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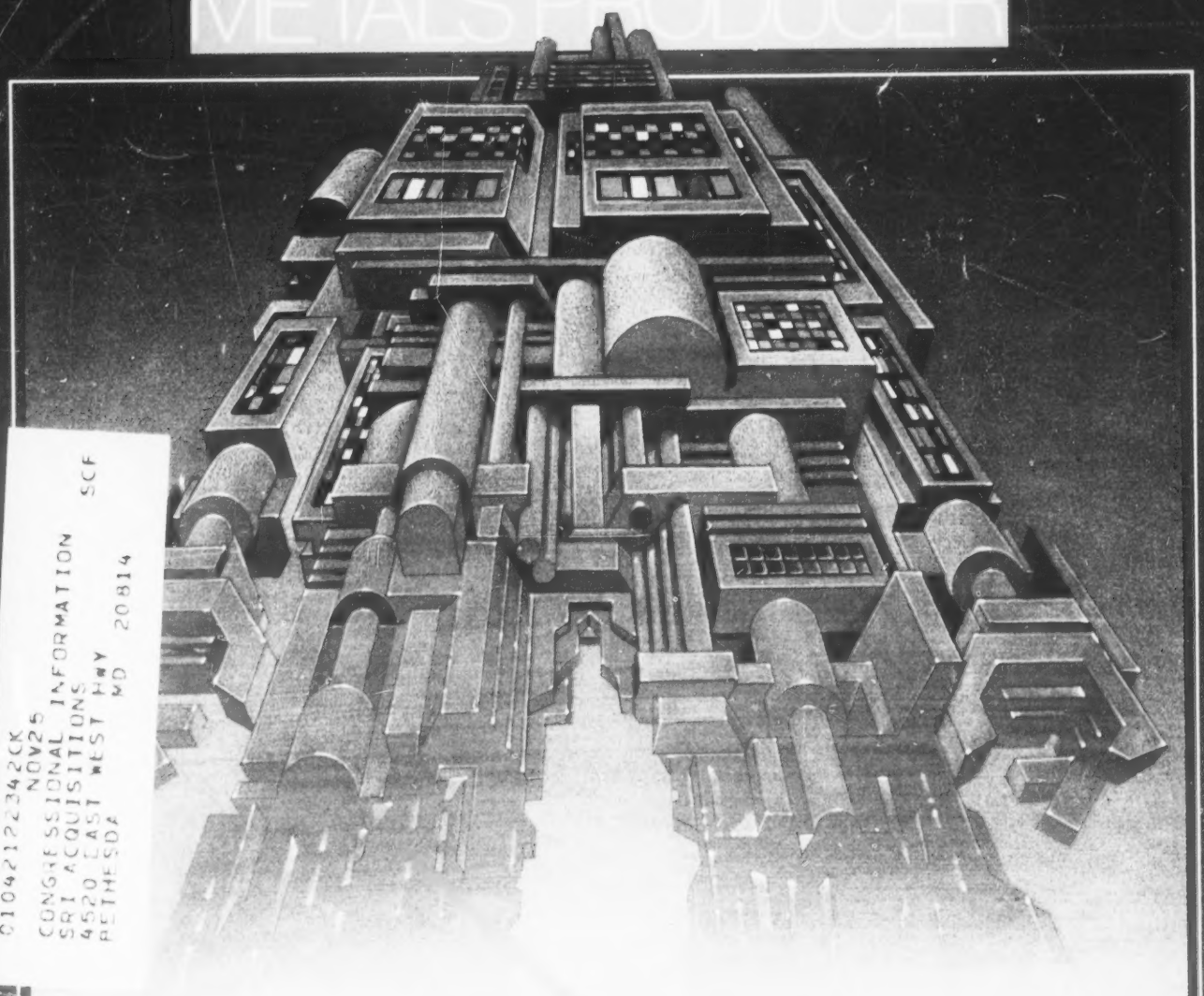

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FACTORY 2000

A VISION FOR SURVIVAL IN THE 21ST CENTURY

WARNING: A COKE SHORTAGE JUST AROUND THE CORNER

JUNE 4, 1984 VOL. 227, NO. 11

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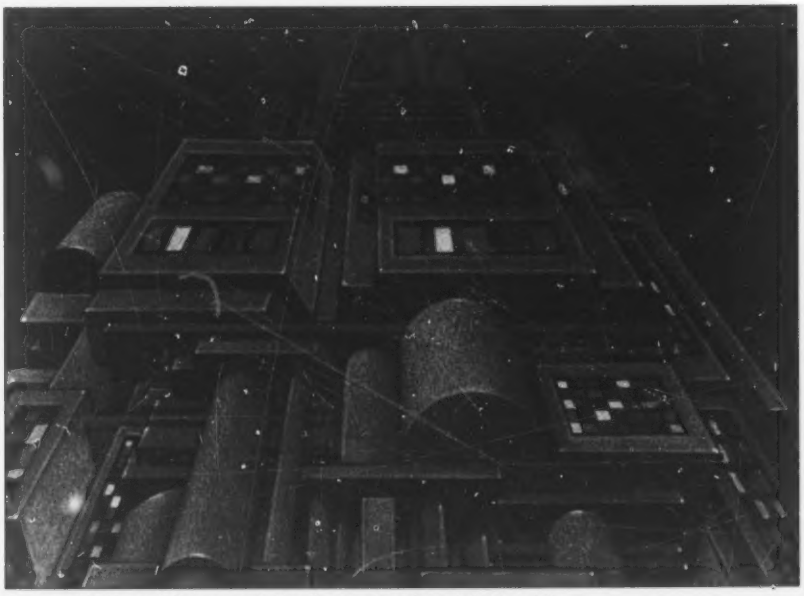

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LIVING OVERSEAS GETS CHEAPER

Despite overseas inflation, American companies are finding it costs less and less to support their overseas executives.

Sampling Overseas Living Costs

Assumed base salary in U.S.: $60,000	January 1983	December 1983
Frankfurt	30,366	26,792
Rome	28,986	26,299
Madrid	26,472	23,046
Buenos Aires	20,902	22,627
Mexico City	13,236	16,982
Hong Kong	29,997	26,743
Tokyo	45,352	44,884
Sydney	27,384	25,461

Source: Global Inflation Report No. 4, April 1984, The Conference Board

BY PATRICIA S. AIMAN

That U.S. dollar may be encouraging imports, but it is also making it less costly for U.S. companies to support their executives in a number of major cities abroad.

A recent report from *The Conference Board* indicated that living costs for such basics as food, clothing and medical care (housing is excluded), declined in 1983 in 18 of 20 cities around the world, primarily because of the strength of the dollar.

The report explained that an American businessman making $60,000 a year in New York City now spends about $24,500 on living costs. But, although costs are higher in most of the foreign cities covered in the report, they actually decreased sharply in a number of major cities during 1983.

The sharpest drop was in Copenhagen, where costs fell from $31,993 to $26,102, but sharp declines were also apparent in Paris, Geneva and Caracas.

The dollar's strength was an insufficient deterrent against the 100 pct inflation jump in Mexico City or the 340 pct rise in Buenos Aires.

But, as noted by J. Frank Gaston, director of Special International Studies at the *Board*, "The dollar has gained to such an extent that it has more than offset the generally faster inflation abroad. It is very likely that the present trend will continue."

The $60,000-a-year New York City executive now working in London spends $25,757 on normal living expenses. Although inflation in the U. K. rose at an annual rate of 4.6 pct last year, the pound depreciated from $1.56 to $1.43. This means that every dollar converted at the beginning of this year was worth 9 pct more in pounds than those exchanged at the beginning of 1983.

More job recruiters on U.S. campuses

One evidence of the revival of the economy is the appearance of more and more corporate job recruiters on U.S. campuses. But, while they are dangling more offers, they are not dangling heftier salaries.

This was discovered in the *1984 Salary Survey* report from the College Placement Council, which found that starting salaries are "remaining fairly stable."

Still smarting from financial pressures, many companies wouldn't project more than 3 pct to 6 pct salary increases through this year.

Other highlights of the survey:

—Petroleum engineers drew the highest salary—$2,528 per month;

—The year may be better than expected for chemical engineers;

—Computer science recorded a major increase in job offers and a monthly salary average of $2,004, up 3.3 pct since July, 1983.

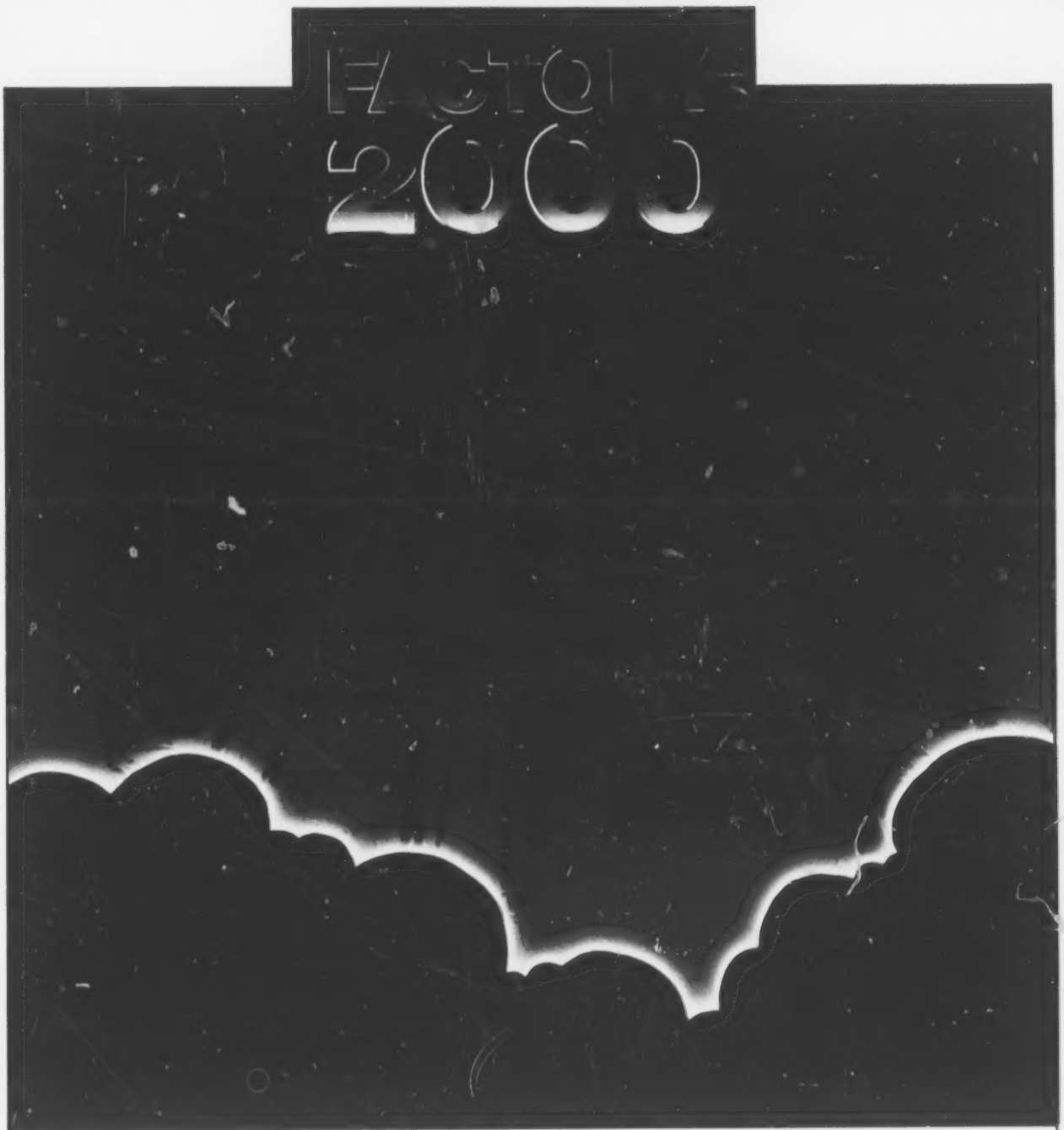
The news was good for graduate students, too, with more offers coming in, but again, starting salaries in more than half of the programs are below the closing offers in the July, 1983 survey.

Data for the survey was submitted by 187 placement offices at 162 participating colleges and universities.

Hard-to-place? This book should help

Job seekers, with two strikes against them, should read Dick Wright's book, "Hardball Job Hunting Tactics." As the director of the Job Search Workshop Program in San Mateo, Calif., he's coached more than 1,000 problem employees, claiming that more than 75 pct of his students find jobs within a few weeks of graduation.

Subject matter ranges from resume writing and filling out applications to overcoming racial prejudices and dealing with rejection. This *Work-in-America Institute* book, which sells for $11.95, provides a no-nonsense approach for single parents, welfare recipients, black teenagers, ex-offenders, the handicapped and senior citizens.

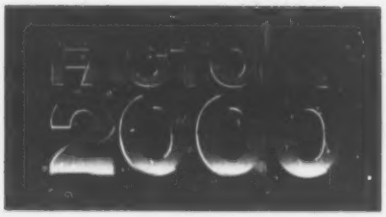


Between now and the year 2000 the factory will change more rapidly than it has in the past 75 years. Firms will either adapt or perish.

WRITTEN BY
ROBERT E. HARVEY
DESIGNED BY
SANDY BUTRYN
ILLUSTRATED BY
RANDY HAMBLIN

The patient is dying. In this case the patient is U.S. industry and its illness is ailing productivity. That's the popular conclusion of theorists who would have us believe that nothing can be done to revive the patient. But the fact is, this illness, this slow death, if you will, need not be fatal. Cures, although often difficult to swallow, do in fact exist.

Before today's ailing factory can be transformed into tomorrow's efficient Factory 2000, healthy doses of philosophy, strategy and technology must be ingested. Recovery can begin immedi-



ately because most of the elements needed for the factory of the future are available today.

According to Thomas G. Gunn, manager, Computer Integrated Manufacturing Group, Arthur D. Little, Inc., Cambridge, Mass. "We have more technology than we can implement in the next ten years."

The major technical tool, of course, is the computer, a machine with the potential to completely restructure today's manufacturing operations and launch industry into the 21st Century.

"On a global scale and by historical standard, we now find ourselves in the midst of a technological revolution on the order of the discovery of fire, the development of the water wheel, the printing press and nuclear power. This revolution will for all time change our way of life like no other change before it.... This revolution is the information revolution based on electronic miniaturization and fundamental logic," stated John R. Holland, manager, Factory Automation Laboratory, Allen-Bradley at a recent CAM-I Conference.

Factories with promising futures will be those in which management effectively harnesses this revolution. However, time is short. Computer technology is a U.S. trump card. But that card must be played soon, while it still has some value.

Rather than make effective use of this technology, however, many manufacturers are floundering amid a growing profusion of hardware, software, and computerese.

However, even more important than coming to grips with new technologies, is the need to develop philosophies and strategies that truly address the financial, human and institutional barriers that stand in the way of modernization.

The development of well-defined, long-range goals and a total commitment from upper management to pursue those goals must be the number one priority. Since manufacturing is going through so many profound changes, those firms unwilling or unprepared to move forward will not survive.

"Manufacturing will change more in the next 15 years than it has in the last 75 years," forecasted William H. Slautterback, director of manufacturing systems, Engineered Metal Products Group, Koppers Company, Inc., Baltimore, and a participant in the White House Computer Conference on Productivity. "The reasons are clear: survival and technology."

Groundwork

Dramatic change, if it is to be managed effectively, must be planned. The groundwork for Factory 2000 must be laid now. However, preparations for the factory of the future cannot be made in the dark. Some light must be thrown on what this factory is to look like, before construction plans can be made. Creating a vision of the future factory is critical. With a clear picture of where we are going, goals can be set and the steps needed to reach the goals can be formulated. Needless to say, a vision itself means little without a strong commitment by management to ensure that that vision eventually is transformed into reality.

But how to transform these visions into reality has been a concern of man from time immemorial.

A master potter bends over his wheel. The wheel spins. The clay becomes a blur beneath his hands. As the potter works, his tools, his hands, his clay, cease their separate existence. They have become but extensions of his imagination.

Because the potter's tools become extensions of himself, he is able to instantly turn his thoughts into creations. Thus, each of his pots is unique and of top quality. His extreme flexibility, his one-of-a-kind products, and his ability to instantly integrate materials, production, and management make him the antithesis of the modern mass-production-oriented, departmentally-splintered factory.

Yet Factory 2000 will in concept resemble more closely the potter than today's factory. For, say experts, in a factory at the turn of the century, the distinctions between activities will become blurred. Integration and flexibility will be pervasive, and an economic lot size of *one* will be approached.

To illustrate the relationship between present and future another way. In rural Japan, a Zen archer slowly draws back his bow, and for a timeless instant: the bowman, his bow, his ar-

row, and the target are one. Then, time resumes its course: the arrow hurries toward the target's center.

The Zen archer hits the bull's-eye when he becomes one with his bow and arrow and the target. Yet in today's factory, not only can't the fragmented departments be sufficiently coordinated to draw the bow properly, close teamwork would be a valueless because the target is either ill-defined or impossible to see. Companies with ill-defined or undefined targets waste much time spraying arrows skyward, hoping that one will someday strike something valuable.

Both stories illustrate dangers that can befall the manufacturer when he enlarges his operation beyond one man. Certain economies of scale are gained through growth, but in the past there has always been a cost: inflexibility and diminishing communications and control, for example. Fragmentation sets in as departments pile upon departments.

"By breaking factories into these units, we erect boxes and walls around functions which then creates enormous political problems," explained Mr. Gunn.

Splintering

Today, in large and not-so-large manufacturing companies this splintering of departments and functions has been carried to extremes. Horizontal Towers of Babel have sprung up which make communications among the design department, the manufacturing department, the finance department, the data processing department, the marketing department, and the front office, very difficult.

A engineer, who had spent much of her life in the manufacturing arena, recently was hired by an accounting firm

Roadblocks to Manufacturing Automation Efforts

Category	Percentage
Lack of Design & Engineering Staff Knowledge (& Time)	73
Lack of Inside or Outside Programming Capabilities	56
Lack of Information on Equipment & Software Capabilities	55
Lack of Machine-to-Machine Interface Capabilities	53
Lack of Central Computer or MIS Staff Knowledge	48
Lack of Mechanical Reliability	45
Lack of Suppliers to Take Entire "System" Responsibility	44
Lack of Communications Format	44
Lack of Electrical/Electronic Reliability	43
Lack of Operator or Foreman Acceptance	38
Lack of Equipment	35
Lack of Higher Management Interest	33
Lack of Outside Consultants to Assist the Effort	27
Lack of Organized Labor Support	26

Figures were obtained by a National Electrical Manufacturers Assoc. (NEMA) survey of member companies.

The percentages relate to the number of firms that indicated a particular category was "very much" or "somewhat" of a problem.

The Booming Factory Automation Marketplace

ITEM	1967	1982	1987	1995	67/82	82/87	87/95
GNP (bil $)	799.6	3059.3	4889	9755	9.4	9.8	9.0
GNP Deflator (1972=100)	79.1	207.1	274.7	418.7	6.6	5.8	5.4
GNP (bil 72$)	1011.4	1476.9	1779.5	2330	2.6	3.8	3.4
Mfg New P&E (bil $)	32.25	119.68	205	419	9.1	11.4	9.3
Mfg FRB Index	100	137.6	186	239	2.2	6.2	3.2
factory auto/000$ GNP	5.59	2.40	3.04	3.83	—	—	—
factory auto/000$ mfg P&E	138.7	61.3	72.6	89.3	—	—	—
factory auto/FRB index pt	44.7	53.3	80.0	156.4	—	—	—
Factory Automation Sales (mil$)	4472	7337	14880	37400	3.4	15.2	12.2
Mfg Computers	2603	2280	3250	5515	−0.9	7.3	6.8
Mainframes	2541	1720	2260	3275	−2.6	5.6	4.7
Minicomputers	62	560	990	2240	15.8	12.1	10.7
CAD/CAM Systems	—	930	2800	9800	—	24.7	17.0
Machine Tools & Controls	1869	3937	7930	18085	5.1	15.0	10.9
Machine Tools	1869	3724	7100	15000	4.7	13.8	9.8
PC	—	213	830	3085	—	31.3	17.8
Robots	neg	190	900	4000	—	36.5	20.5
Coating	—	48	180	680	—	30.3	18.1
Welding	—	52	210	800	—	32.2	18.2
Material Handling	—	40	255	880	—	44.8	16.7
Processing	—	50	255	1640	—	38.5	26.2

Source: Predcasts

which wanted some manufacturing expertise to upgrade its management support capabilities. She emphasized that the differences between the business accountant and the manufacturing engineer went well beyond simple ignorance of the other's profession. Because each spoke a very different language and thought about production and management in very different ways, it was very difficult to communicate, even at very basic levels. Industry appears to have spawned a number of divergent cultures.

The roots of this compartment approach to manufacturing are buried in history. But the persistence of industry to continue to do things the old-fashioned way can be traced to today's outdated management techniques and mediocre management—management that lacks vision and commitment.

Divide & conquer

"Traditionally, our approach to manufacturing processes has been much like the classical industrial engineering approach to problem solving. Divide the problem into small pieces and develop the best solution for each one," explained James M. Apple, Jr., senior vice president, SysteCon, Inc., Duluth, Ga. "In doing so, we presume that optimizing each element will result in total optimization of the manufacturing plant. This approach led us to solutions that represented islands of automation."

The major rationalization for the use of this classic approach came from its ability to reduce direct labor.

"However, these systems were as inflexible as they were productive. And, they are unable to adapt readily to changes in processes and market demand," Mr. Apple said. "In order to keep efficiency measures high, we made long production runs and created large inventory within the manufacturing cycle."

To react quickly to new overseas competition and a rapidly changing marketplace, firms are finding that they have to be fast on their feet. But the weight of too much inventory, too many inefficiencies, and calcified operations has begun to take its toll. Most CEOs today have financial, legal or marketing backgrounds and know too little about manufacturing and are of little use in formulating comprehensive rejuvenation strategies.

Executives are just beginning to realize that something drastic must be done, that new visions must be dreamed, that new goals must be set, that new commitments must be made.

However, before these new visions can become a reality, before Factory 2000 can be realized, four major obstacles must be overcome. The major barriers to Factory 2000, according to Mr. Holland, are financial, human, institutional, and technological ones.

Obviously, the financial obstruction is the first roadblock that must be dealt with, for without funding, nothing gets built.

FINANCIAL BARRIERS

Just as executives must be open to new ways of looking at manufacturing, they must also be open to ways to financially justify investment in the factory of the future. For instance, the purchase of an entire flexible manufacturing system (FMS) should not be justified in the same way that an individual machine tool is justified. An FMS system probably will have a significant strategic impact as well as an impact on productivity. Somehow that strategic impact must be evaluated.

"My experience has convinced me that this financial issue is causing some real problems for executives," said Frank T. Curtin, general manager, Industrial Automation Systems Dept., General Electric Co., at the March CIMCOM conference in Washington D.C. "These new technologies have a huge potential to increase productivity, but that potential is being roadblocked in many cases by the misuse of financial analysis tools. To be blunt, we are not getting off the dime because we are not sure how to calculate and measure what the return will be on investing that dime in flexible automation."

Shocking data

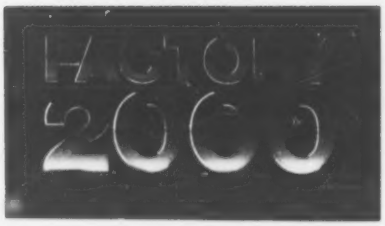
According to a recent Boston University School of Management survey, 78 pct of the respondents felt that, "Most businesses in the U.S. will remain so tied to traditional, quantitative investment criteria that they will be unable to realistically evaluate the potential value of computer-aided manufac-

On a global scale and by historical standard, we now find ourselves in the midst of a technological revolution on the order of the discovery of fire, development of the water wheel, the printing press and nuclear power. This revolution will for all time change our way of life like no other change before.

Corporation control will again be in the hands of manufacturing experts

1920-1950	Manufacturing
1950-1970	Marketing
1970-1985	Finance
1985-20xx	Manufacturing

Source: W. H. Slautterback, Koppers



turing options."

Using traditional investment formulas, management is confused about how to evaluate revolutionary computerized technologies. So, they are not buying them. But management is not buying systems for other reasons as well. Since most executives today come from financial, marketing, or legal backgrounds they often simply do not understand the impact of new technology. They know little about design and manufacturing and even less about computers. On top of that, they don't know who to turn to, to teach them what they ought to know.

"A key reason for the lack of top management action is these managers really don't know who to believe any more," said Mr. Gunn. "They seldom have complete trust in their own people because they are well aware of the vested interests within their own organization. They don't know which vendor to believe because the vendors have an inherent conflict of interest—especially since each vendor sees a different 'solution' to problems. Even consultants can be suspect because they may have a parochial or product-oriented point of view about something."

Buffeted by confusion, misinformation, and technological jargon, top management understandably has not thrown itself wholeheartedly into purchasing advanced equipment. Then, when companies have bought equipment, it has been for the wrong reason. Not knowing how they are going to use the equipment, (a robot for instance) but not wanting to see the technology pass them by, top management on a gut reaction, splurges on one piece of equipment. Sometimes equipment purchased in this way can have value as a learning tool. However, blindly purchasing advanced technology and then expecting it to benefit the operations is extremely naive.

If one word represents the fundamental direction of computer technology it is 'integration.' The goal of integration is to get the diverse elements in manufacturing working in harmony. The primarily tool that will bring this integration is computer-integrated manufacturing (CIM), leading eventually to the computer-integrated business, the factory of the future. Buying pieces of CIM without seeing the complete picture is just asking for trouble.

However, "Rarely do CEOs think about and plan for this kind of factory automation from a sufficiently big picture or a sufficiently high level," explained Mr. Gunn. "They use their traditional capital budgeting techniques. The result is that they have not been able to justify investing in that risky long-term factory automation program.

"They really don't have the experience to deal with factoring benefits other than direct labor reduction or increased capacity into their justification calculations. So, what often happens is that even when they do look at a total system, they think, they will go in and cherry-pick the one or two most attractive parts of that system and implement those. The other parts, not as attractive, often don't exceed whatever criteria the executive is using to justify spending. As a result, the other parts of this automation package never get implemented and the firm never gains the needed synergy available from the system as a whole."

Cost/benefit formulas

What too few executives realize is that flexible automation systems radically alter the economics of automation. "What is urgently needed are new cost/benefit formulas and measurements," emphasized Mr. Curtin of G.E.

Computers will supply the life blood for the Factory 2000

"new manufacturing economics, if you will, that go beyond the usual return-on-investment (ROI) evaluations to take into account the total impact of automation on the business. Because these technologies don't just change the factory floor. They change the entire business in new and important ways."

Those new and important ways, however, are hard to quantify. Most firms have little problem analyzing the pros and cons or automating a particular operation or machine tool. When a mixture of systems are involved, however, these firms begin to flounder. "...it is suggested that the real return from large scale automation will be incurred when it is understood that what we should be concentrating our automation efforts on is the inter-task activities which are normally ignored in terms of cost justification analysis," explained Mr. Holland. "Inter-task automation addresses the question of effectiveness as opposed to efficiency."

All the insular departments in a factory can be very effective when looked at individually but very inefficient when viewed as part of the much larger factory system. Too often integrated system solutions (where the whole is greater than the sum of its parts) are ignored because firms find they have no way of accurately determining whether the system can be economically justified. But benefits of integration are very real. Witness the separate inefficiencies but overall effectiveness of Japanese just-in-time production: In Japan, unless the work area directly ahead of a particular employee's workstation needs a part, that employee reads a book, twiddles his thumbs, or does something else with this time. His work station stays idle. The workstation, in isolation, seems inefficient. When looked at in the larger context of providing a part exactly when it is needed, the workstation becomes a very effec-

tive force in reducing work-in-process inventory.

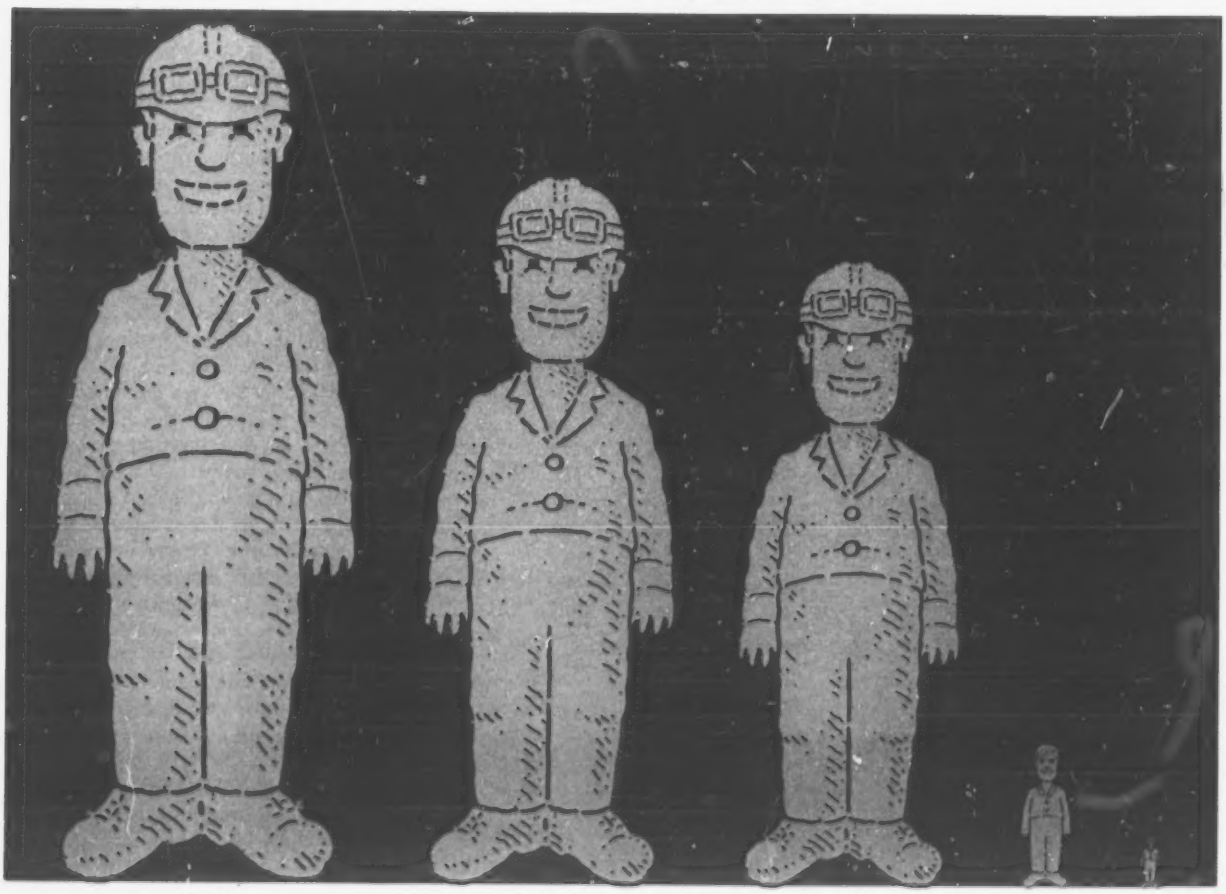
A recent Arthur D. Little report told of a Japanese manufacturer who decided to install a flexible manufacturing system. This system enabled the manufacturer to cut back the number of his machines from 68 to 18, the number of his employees from 215 to 12, and space requirements from 103,000 sq ft to 30,000 sq ft. Process time was dramatically cut from 35 days to a day-and-a-half. But the financial return over the first two years as only $6.9 million on an investment of $18 million. Now, despite the numerous strategic benefits such a plant would give a manufacturer, one the basis of conventional accounting principles, states the report, this low return on investment would be difficult if not impossible to justify.

"The point is," pointed out Mr. Curtin of G.E. "Many manufacturers continue to make the mistake of looking at flexible manufacturing system investments as tactical decisions with only short-term financial implications—when in fact they are strategic decisions with far-reaching competitive implications.

Long-term savings

"Automation provides permanent long-term savings and a host of intangible benefits...such as higher quality, shorter production runs, increased worker satisfaction, faster responses to

The Shrinking Percentage of the U.S. Manufacturing Workforce



changes in market demand, quicker throughput, greater flexibility and on and on."

Because manufacturers continue to focus on the efficiencies of the individual work area and ignore the big picture, major cost cutting efforts are directed at replacing a man with a machine tool or a robot. These efforts are misdirected. While direct labor accounted for a majority of product costs in the past, it does not today.

"Direct labor accounts for an average of only 10 pct of manufacturing costs, while material costs are 55 pct, indirect labor is 15 pct and overhead costs total 20 pct." said Mr. Curtin. "The big hits lie in the bigger pieces of the pie: material, inventory and overhead costs."

Once a firm decides it can financially justify an integrated system, it must next turn its attention to the people who will be manning this system. The company is now confronting the two biggest obstacles on the road to Factory 2000: the human and institutional barriers to automation.

HUMAN AND INSTITUTIONAL BARRIERS

Once the financial hurdle is negotiated, two even larger barriers in the path of Factory 2000 must be surmounted. These barriers: the human and institutional barriers are so interrelated that any discussion must address both problems together. It is humans, after all, that comprise the corporate or institutional culture.

"The lack of implementation of large scale automation is often related to human factors.... It includes a resistance to change. It involves unionism. It involves people who are 'obsolete.' " said Mr. Holland.

As well as the resistance to change, a factory culture exists that is even harder to alter. Traditionally, jobs have been done a certain way, and traditional habits are hard to break. Departments usually have operated in a particular way for so long that they have substantial inertia that must be reversed if change is to occur. But if the new vision of Factory 2000 is to be embraced, if new philosophies are to be adopted, and new strategies carried out, and if integration is to be more than a buzzword, people and departments have to change.

Communications

A major task, before operations can be integrated, is just getting departments to talk to each other.

Management information services (MIS) people have to leave their ivory tower and learn more about development and production. And as computer-aided design and computer-aided manufacturing (CAD/CAM) grows more popular, designers and manufacturing engineers will have to do more talking.

"Clearly there is a need for closer ties between our development organizations and our manufacturing organizations," stated Jim McDonald, general manager, Manufacturing Systems Prducts, IBM, "It is critical that these groups work hand-in-hand to put products out." A large gap between the two remains today. "Analyzing from a historical perspective, twenty years ago I think people came out of school knowing a lot more about how to manufacture the part that they designed than they do today. The designer needs to know how to design products that can be easily manufactured. There are tremendous training problems that need to be addressed to do that. In addition, one must continue to develop the skills of the manufacturing group so that it can provide input to the developer."

By getting the designer and manufacturer closer together, the chance of the developer designing a part that is difficult or impossible to produce is reduced. Efforts to move the two departments closer together are slow in achieving results because of the difficulty of converting the geometric information of the designer into useful information for the manufacturer as well as transforming manufacturing data into information useful to the developer. These efforts also are hindered by a corporate culture that tends to keep the to professions apart.

"There is no way that computer-integrated manufacturing will become a reality unless the people side of the scale is addressed;" emphasized Dan Ciampa, executive vice president, Rath & Strong, Inc., management consultants. "People and not technoiogy will

Traditionally our approach to manufacturing has been much like the classical industrial approach to problem solving. Divide the problem into small pieces and develop the best solution for each one. This approach led us to solutions that represented islands of automation.

My experience has convinced me that this financial issue is causing some real problems for executives. These new technologies have a huge potential to increase productivity, but that potential is being roadblocked in many cases by the misuse of financial analysis tools.

realize the marvelous potential of CIM, but unless we become smarter about managing people, CIM will go down in history as nothing more than a good idea whose time never came."

As mentioned, technological developments have advanced so rapidly that many of the pieces for Factory 2000 are already available. "But just having a lot of sophisticated, state-of-the-art options is not going to ensure the effectiveness or efficiency we need to achieve higher quality," continued Mr. Ciampa. "The only way all of these elements can produce more effectively and efficiently is if they are integrated. Machines, computers, and software cannot be integrated unless the various departments that control and use these resources are integrated. This task is more formidable than has been the task of developing computers, software, and machinery of automation. This task must be accomplished in spite of the management philosophy and climate within most firms in this country.

"The traditional manufacturing climate discourages integration, rather than encourages it. It works against a common vision by treating people at different organizational levels in different ways. It blocks unity of purpose by encouraging outdated management philosophies and approaches."

As companies move toward Factory 2000, major changes have to occur in the way people do things. Mr. Ciampa has suggested several that will occur (see table p.47).

—As manufacturing systems become more flexible, permitting them to react quickly to changing market conditions, people will have to adjust by becoming more flexible themselves. As job content changes and broadens, people will have to acquire proficiency in several skills.

—Also, "The need for better interpersonal communication will increase as we move toward CIM," said Mr. Ciampa. "This will bring the opportunity for more face-to-face contact between people and for better communication." In addition, organizational structures will have to be changed to facilitate this need for increased communication.

—Roles and relationships will change requiring people occupying certain jobs to behave differently and to perform different tasks in those same jobs. "One opportunity of this change is to enrich and give more meaning and more challenge to jobs in the workplace. Another is to better control the decision-making process by clarifying roles and limits of authority."

—Another trend that will take place is that decision-making authority will be pushed to lower levels as equipment and systems that do more are made available on the shop floor. Being able to make more decisions and exert more control should bring greater job satisfaction to the factory floor; however, when control is moved to lower levels it must be taken from managers in higher levels. These managers could well resent this erosion of their control.

—Finally, "More involvement of the users of new equipment and systems will be necessary in determining what will be designed, and how it is to be used. The opportunity here is that new systems will better meet the needs of the people who are to use them and those people will be more committed to making them succeed," concluded Mr. Ciampa. A new system is of little value if it is not operated effectively.

Even if not planned for, the very presence of computer-integrated equipment on the shop floor will have a large effect on the way people do their jobs which will, in turn, affect the way they interact with others.

Operators

"As automation finds its way into the factory, an obvious consequence is that the operator is removed from the proximity of the machine or process. Even if the operators of machinery are not completely eliminated, they will, in general, not be as close to the machine as in the un-automated factory. As the operator backs away from the machine, the nature of his role will change from one of participating directly in the control loops at the machine level to one of supervisor and attendant," explained Mr. Holland of Allen-Bradley.

Eventually, as Factory 2000 takes shape, the operator will be entirely disengaged from the active control process. Companies that do not understand or accommodate the cultural implica-

tions of this process will eventually pay for their oversight.

With these upcoming changes in the roles and relationships of company members, it is important that top management address the potential people problems with as much concern as the technical problems. As nearly every consultant and automations expert will attest to: organizational change must begin at the top. Top executives must not only lead the way in implementing Factory 2000, they must jump into the automation effort with both feet, know what is going on, and understand the big picture. "...the CEO must describe how the company can be under CIM and in so doing paint an image of the future that is exciting and compelling. The job of creating a vision cannot be delegated," said Mr. Ciampa.

Because of the human element involved, CIM must be a step-by-step process. A manufacturer, with enough money, can plunk down $15 million for a full-blown flexible manufacturing system (FMS). But no matter what he spends, he cannot instantly enlighten the workforce. Changing a corporate culture takes time. It can take a long time: five years or more. Automation efforts which attempt to solve productivity problems in one fell swoop, which refuse to recognize the the human aspect of automation, are doomed to failure. Despite the revolutionary computer age we now live in, the implementation of computer-integrated manufacturing must be a gradual evolutionary process.

As the year 2000 approaches, the hierarchy in a manufacturing operation will be much different than it is today. With each employee assuming more control of his/her operations, fewer layers of management will be needed. In addition, the relationship between the various layers will be much less formal than today. This informality will grow as the management content of employee jobs increases and the envolvement of top management in manufacturing grows.

"In addition to various departments being integrated in this effort, there needs to be a new partnership between salaried and hourly workers," explained Mr. Ciampa. "We all recognize that CIM means enormous changes on the shop floor—and those changes cannot be successful unless the direct labor workforce is committed to success. They must feel involved and that means that they must participate in determining how CIM will take shape in their company. In order for this to happen, the traditional adversary relationship between management and labor must change. It is dysfunctional and wasteful."

Mr. Ciampa suggested that for labor to be more cooperative it needs a bigger piece of the action, "....emotionally through influencing outcomes and financially through plans such as gainsharing." Before Factory 2000 can become a reality, both management and labor are going to have to reassess their positions.

Education

If the corporate cultures are going to change and employees are going to be assigned new jobs, education will be playing an increasingly important role in tomorrow's factory.

Today there is a need to see beyond barriers, to understand the interconnecting of various disciplines. People like systems engineers will be in increasing demand. Today's systems encompass a wide variety of technologies such as electronics, mechanics, hydraulics, computers and computer programming, and laser optics to name a few.

But do the generalists who are cross-trained in many disciplines exist today?

"If I was asked that question two of three years ago if schools teaching this kind of education existed, I would have said no," responded Jim McDonald of IBM. "However a number of schools are starting to put together some excellent programs in the area of manufacturing systems engineering and many schools that do not yet have the programs are interested in starting them."

Not only will technical people with new skills be needed, people with new human relations skills will be called upon to interact with the employee of the future. Today's personnel departments are a far cry from the human resources departments soon to be needed.

"One of the biggest challenges will be to find and to develop managers and

There is no way that computer integrated manufacturing will become a reality unless the people side of the scale is addressed. Unless we become smarter about managing people, CIM will go down in history as nothing more than a good idea whose time never came.

Regarding standards it is time for all of us to work harder than ever to put aside short-term tactical advantages and proceed to develop the communications, electrical interfaces to allow the user to buy American. We cannot become the standard for excellence if we are non-standard.

supervisors who can make the most of the technology that is being made available. This will require defining the areas of competence needed of managers and supervisors in the era of CIM. Further they will be responsible for developing training programs geared to raising people's knowledge, skills, and behavior so that they can perform at that level," said Mr. Ciampa. "We should look to a new breed of human resources professional to help."

The final barrier to automation that has to be addressed is a technological logical one. However, the problem is not primarily a lack of necessary technology but the inability to integrate, to connect, this technology together.

TECHNOLOGICAL BARRIERS

Technology shapes the building blocks of Factory 2000. The specific building blocks will be discussed later.

When taken as individual building blocks or parts to the factory automation puzzle, many of the pieces of that puzzle have already been developed. The main problem is not that there are not enough pieces but that the pieces don't yet fit together.

It is not the case of just a minor adjustment here and there. It is very difficult to get any two pieces of factory equipment to talk together unless they have been made by the same vendor.

What is needed are standard ways of linking equipment so they can communicate. A manufacturer ought to be able to easily attach a programmable controller with a minicomputer and a robot and have them talk back and forth. But right now this task is next to impossible.

"Regarding standards, it is time for all of us to work harder than ever to put aside short-term tactical advantages and proceed to develop the communications, electrical interface, and software interfaces to allow the user to buy American." said Mr. Holland. "We cannot become the standard for excellence if we are non-standard."

General Motors

The Company that is leading the way in standards development is General Motors. The firm is working with control manufacturers and national and international standards committees to produce a set of standards that suppliers must adhere to if they are to sell to GM. The hope is that once GM defines and adopts these standards, other firms will begin to accept the same standards for their companies.

"Productivity improvements within General Motors manufacturing generally began with the automated control of single processes such as machines, conveyors and product test stands," said Ron Floyd, who is with the advanced product and manufacturing engineering staff at the General Motors Technical Center. Over time this automated control has expanded to a functional orientation, with a control or supervisory system encompassing an entire function such as material handling or an engine head line."

Presently, GM uses approximately 20,000 programmable devices within manufacturing with projected quantities to reach 40,000 in two years. The benefits obtained from increased manufacturing automation associated with these devices is substantial.

"A major step remains to be taken however: the move from automated functions and processes to the computer-integrated 'Factory of the Future,' " said Mr. Floyd. "The factory of the future concept requires integration of separate automated processes into a sophisticated, cohesive whole. Timely information must be available for exchange between automation centers and presentation to management. This information will enable timely and accurate decisions—implemented online, for optimized manufacturing. Data communication among automated processes in some cases is not practically possible. In other cases, skilled data processing professionals are required to implement custom interconnections."

The solution to the data communications incompatibility problem at GM is establishment of standards. GM would like to set up communications networks and be able to attach equipment on that net. Today, however, vendors cannot use a common network because each vendor supplies a unique protocol which either cannot be emulated by other manufacturers or can be only at great expense.

"The lack of compatible communi-

cations hardware and software results from the lack of viable networking standards," explained Mr. Floyd."To date, computer manufacturers have generally invented their own communications protocols, many of which are proprietary. Within a facility where several computer manufacturers are used, the result is incompatibility. The need for the establishment of viable standards is here today within manufacturing. Just as important, we need wide vendor support of such standards with cost effective and compatible data communication products."

Although they still must be linked together, a lot of advanced technology is already on the market, ready to be incorporated into tomorrow's automated factory. A look at what some of this is and how it will develop over the next decade-and-a-half is is order.

PIECES OF THE PUZZLE

Moving toward Factory 2000 is not just surmounting barriers it is also assembling elements. Many of the parts for that factory, be they strategic equipment, software packages or pieces of hardware, are available today. As important as these elements are, they must be integrated into systems before their potential truly can be realized.

The goal is the creation of computer-integrated manufacturing or CIM. CIM provides the blueprint which designates how the diverse parts of the factory of the future will be linked together. "...CIM is a corporate strategy—nothing more, nothing less," explained Charles M. Stata, Manager, New Venture Technology, Wang Laboratories Inc., Lowell, Mass. at the 1984 CIMCOM Conference. "...CIM is not a new software system. It is not hardware. It is not a product which you can go out and buy off the shelf."

While hardware and software are essential to implement the technology, CIM is is a way of doing business, not a pile of equipment. "CIM starts with a mindset," he continued, "which dominates the selection of equipment, the choice of software approaches, and most importantly, how we think of our business' growth."

Defined by Mr. Stata, "CIM is the methodology for automating the gathering and sharing of information among computer systems to establish a closed loop in-time feedback system for effective planning and control."

By accepting CIM as a legitimate strategy, manufacturers are beginning to recognize that the chief business of manufacturing is the gathering and manipulation of information. In today's factory much more time and effort is spent collecting and analyzing geometric and alphanumeric data (letters and numbers) than ever is spent in actual metalworking.

CIM recognizes that the success of tomorrow's factory depends on its ability to gather and share data. If data is so important, it becomes critical that a corporation "adopt a set of rules which will govern the time frame, data forms and interconnections used in the collection, storage and sharing of data among the authorized applications and users," said Mr. Stata. "Data, then, becomes a controlled corporate resource rather than an application dominated entity."

If information is such a valuable commodity, the ability to transfer the correct information to whoever needs it, becomes an important task. Building a comprehensive pipeline that carries data to all parts of the company (and even outside the company to vendors and suppliers) is a major goal for CIM users. A company's information architecture describes the shape of this data pipeline. But improving a firm's data architecture is half the problem, for once the data gets to where it is supposed to be going, it must arrive in some form that can be used and understood. The information also should arrive when it is needed. All these problems regarding where, when and how data is to be sent are being addressed by the CIM concept.

"Now, if you don't consider the data architecture as most factories don't today, you will buy a component or system that is justified on its own merits and will paint yourself into a concrete

CIM Will Bring Major Changes to Employees

Change	Opportunities	Dangers
Job Content Change	More Growth Opportunities	More Unemployment Worker Discontent
Better Interpersonal Communication	More Face-To-Face Contact Better Working Relationships	Worse Working Relationships
Roles And Relationships Change	Enrich Jobs and Offer More Challenge and Satisfaction Better Control Decisions	More Decisions Not Made More Confusion People Not Able to Adapt
Decision-Making Authority Pushed Down	Greater Motivation Faster Decisions	Threatening Vertical Checks and Balances
More User Involvement	Better Meet Needs More Commitment	Longer Development Time Complicate the Process

Source: Dan Campa, Rath & Strong, Inc.

corner when you want to automate up to the next level," cautioned Malcolm L. MacFarlane, vice president, Gartner Group Inc. "At this next level where you have to attach two systems together, you will find those systems mutually incompatible."

Developing a unified architecture that that takes into account how data is structured in a particular company is an important aspect of CIM. Also important is knowing what form the data is in as it travels through the pipeline.

"The data which is collected, stored,

The factory of tomorrow begins with an exciting collective vision.

computed and reported resides in the computer in a form which most of us have little knowledge of," explained Mr. Stata. "Yet I submit that this is the single largest element which needs close control. Traditionally, we, the users, have not cared how the programmers coded the part number. With an integrated environment, you need to care because you want to share between previously isolated systems. Across your business a part number should be represented commonly so that all of your systems will recognize the part number the same."

According to Mr. Stata, CIM has three identifiable characteristics. The first is automated information gathering, which means information is collected by a computer not a piece of paper. The second characteristic is net working, which allows the transfer of data between systems, and the last characteristic is the shared data base.

A data base is simply the systematic organization of data files for easy access, retrieval and update. Information within a data base is not tied to a particular program but can be accessed when needed by all types specific application programs.

CIM is made up of a number of subsystems and and technologies. Some of the most important include computer-aided design and computer-aided manufacturing systems (CAD/CAM). Computer-aided process planning (CAPP), computer-aided quality inspection, robots, numerically controlled machine tools (CNC/DNC), automated materials handling, manufacturing resource planning (MRP), group technology, laser systems, flexible manufacturing systems (FMS), and manufacturing cells. In the future, artificial intelligence (AI) will be an important part of CIM.

Key ingredient

The one indispensable element in CIM is the computer itself and its accompanying software. "Clearly, computers will become smaller, more powerful, less expensive, and will therefore see increasing use. In tomorrow's factory, standards will create compatibility between computer brands as well as with other intelligent technologies. In fact, the computer will be a tool, just as a hammer is to a carpenter; the brand name will be insignificant as long as the tool is functional and reliable." predicted Mr. Slautterback of Koppers.

Computer keyboards will probably be replaced to a large extent by touch screens and audio commands. The use of voice commands for a computer, however, present problems. It would be difficult for a manager on the shop floor to yell a command to one computer, without having another respond to that command, for voice cannot be directed to only one particular spot.

In CIM the hardware is only as good as the software that runs it and software continues to improve the computer's capabilities.

"If you look at software as having reach—that is, having the ability to reach in front of itself and in back of itself and understand what is going on, new developments are occurring that are designed to give software that extra reach," explained Ray L. Dicasali, vice president, Manufacturing Systems Div., Management Science America, Inc. (MSA). "One of the main complaints of manufacturers is that they do not get good forecasts from marketing. As a result, the factory sets up its schedules and then must change them at the last minute. We want our manufacturing resource planning (MRP) system to reach out to a customer's order management system."

By extending the reach of software beyond the loading dock and into the marketplace, manufacturing people now have an early warning system, which warns them much sooner that changes are coming.

Software is reaching into other areas as well. "Another complaint from manufacturing people is that engineering changes come through at inopportune times. Quite often engineering changes are coming through either because there is an improvement that is needed, or a part that used to be available isn't. You have to make substitutions, but these last minute production changes hurt productivity," explained Mr. Dicasali. "We think that the reach of the manufacturing materials system should be back into the engineering data base to provide early warning of an engineering change."

A third area that software is reaching into is the financial and cash management areas.

Functional integration is another direction of software development. Briefly, this means that software applications are not only integrated physically but it is also integrated logically. This means that a manufacturing software system, for example, would know its particular role and how it effected other systems down the line.

Software advances

Some of the trends in software development, according to Kenneth A. Fox, vice president, research and development, ASK Computer Systems Inc., Los Altos, Calif., include the growing use of modular software which allow manufacturers to build toward the factory of the future step by step. Modules from ASK include MRP, shop floor control, inventory, work-in-process, purchasing, capacity and resource planning and has also added accounting packages, field service, payroll, and human resources. Linked together the modules form what is called an interactive, real time system.

"I think a major trend is the move toward standard software products (in the past, big software users developed much of their software internally). I think that this standardization must occur before these computer-integrated manufacturing technologies can be cost-effectively purchased by the average manufacturer," said Mr. Fox.

In the future most companies will use purchased software packages, but where unique or proprietary software will be needed, natural languages will exist that will allow an individual with no knowledge of programming languages to create his own software.

"Also," said Mr. Fox, "I see the need for systems like ours to be connected to many more diverse kinds of equipment for improved data collection. Today input really comes mostly from user interaction with a terminal, but there are lots of more specialized types of data collection equipment: bar code readers, for example."

Besides computer hardware and software, the next essential element of Factory 2000 is a flexible manufacturing system. FMS, which has been defined by Mr. Slautterback as the orderly, systematic arrangement of equipment (primarily machine tools, robots, measuring systems, and material handlers) to perform manufacturing operations on a group of similar parts, under computer control, without human intervention.

While there are about 30 true FMS systems in the U.S. at present, Mr. Slatterback predicted that there will be over 10,000 by the year 2000. "The logical progression from NC to CNC, to FMS, to the Unmanned Factory is in process," he stated.

The great value of FMS is that it is flexible and automated. A system can handle one type of part or a random group of related parts with equal ease. It can also run unattended for long periods of time.

The main components of an FMS are machine tools. A major problem with machine tools today and one that hinders their efficient usage in FMS systems is tool ware and breakage. In an automated system, no one is around to change a broken tool. As time goes on however, "The concern about tool wear and breakage will be reduced by using such techniques as energy beams and electrical discharge," predicted Mr. Slatterback. "Where this is not practical, exotic materials superior to ceramics and carbides will be developed. Predictive maintenance software and tool failure sensors are already being applied. Machine tool manufacturers will include coordinate measuring as a part of the normal functions of the tool; that, together with photo imaging, vision and other sensors will perform the inspection tasks."

As machine tools and robots become more sophisticated and more flexible, the material handling systems that link these systems must also become more intelligent and more versatile. The full potential of tomorrow's manufacturing systems only will be realized if they are continuously kept busy. Parts and materials must flow in an uninterrupted stream between machines, morning, noon, and night.

Islands of automation

Material handling systems will be crucial to the maintenance of this flow. Just the right amount of items must be brought to just the right place at just

Robots are a critical element of flexible manufacturing systems and cells. These robots perform operations such as material handling and changing the tooling for one or more machine tools. In the future with the assistance of accessories like the laser, robots will become increasingly involved in metalworking.

A manufacturer searching for better ways to to produce parts has to be very careful that he does not turn too quickly to technology for the quick fix he needs to pep up his sagging productivity. When re-evaluating company philosophy and startegies, the consideration of specific technologies should occur only very late in the process.

the right time. In the future, material handling will provide the critical physical linkage that integrates the islands of automation in the future factory.

"I think that the challenge for material handling is to able to interface with the islands of automation that are growing up in the factory," said Walter P. Adams, director of automated systems and controls, Portec, Oak Brook, Ill. "Today, the large changes in material handling are occurring primarily in software." Software is being developed that interfaces with material handling equipment and other machinery on the shop floor.

According to Mr. Adams, as late as the late 1970s, very few guided vehicle systems had any sort of computer control other than the controls directly on board the vehicle. Today, however, the majority of these systems have a central direct computer control.

As to where material handling is going: "We will become much more involved in system integration. In fact we will be the systems integrators, the ones who really help put the whole thing together," explained Mr. Adams."

The major challenge facing the material handling industry is finding ways to interface handling equipment with the great divergence of hardware and software that can be found in most factories. Each robot or machine tool must be catered to a little differently, since no uniformity in equipment exists. Most machine tools, for example, have different load/unload mechanisms and come in different sizes, so most have to be interfaced differently.

Robots

A more localized type of material handler is the robot, although by the year 2000 the robot and the guided material handling vehicle will be one and the same. Eventually robots will be mobile, with the capability of being programmed to go anywhere in the factory. Although today's robots are not very bright and perform simple, repetitive tasks such as spray painting, material handling, and welding, tomorrow's robots, with more intelligence and advanced sensing capabilities, will be able to perform a wide variety of tasks.

According to an executive summary of robots prepared by the Yankee Group, Boston, there are certain dominant trends in robotics today. For one thing, while robots are becoming less expensive, they also are also developing a much greater range of capabilities. For another, robots are beginning to be looked at as advanced computer peripherals (like a printer, for example) and not as machine tools. In the future, states the report, "Robots will become more goal-directed; data will be input in plain English and converted to control procedures or subroutines. Also, human interfaces for programming will be developed for non-explicit commands."

Robots are a critical component of flexible manufacturing systems and cells. These robots perform operations such as material handling and changing the tooling for one or more machine tools. In the future, with the assistance of accessories like the laser, robots will become more involved in the metalworking and metal cutting operations.

With or without robot controls, the laser will become increasingly popular in the factory. For although it can be expensive to operate, its versatility and its accuracies make it an ideal tool to be found in an advanced manufacturing cell or system. Lasers can not only cut, weld, heat treat, and clad various materials, they can also help count, inspect, and measure.

A lot of work is being carried on today in attempting to incorporate lasers into manufacturing systems.

"One of the things we are trying to get together for demonstration is a flexible manufacturing cell. And this cell would take two large-diameter pipes, and would attempt to join those pipes at a funny angle," explained Don Bennett, president, Coherent General, Palo Alto, Calif. The company is a two-month-old joint venture between General Electric and Coherent, Inc.

To prepare the pipes for joining, the laser would cut a hole in one pipe where the other is to be joined, cut the end off that other pipe, and then put the two pipes together and weld them.

Lasers in a manufacturing cell will be increasingly common. Another trend will be the use of lasers on machining centers to do operations that the machine tool is unable to do. Coherent General also sees robots as suitable

partners for it's lasers. To this end, the firm has just introduced a laser-toting robot.

"We will see robots in the future with lasers built right into their arms," said Mr. Bennett. Robots with lasers and vision systems would be able to weld, measure, and do all sorts of metalworking operations.

Future lasers will increase their flexibility by simply changing a lens.

"We have developed the concept of a laser with a tool changer. This tool changer will be loaded with what we call optical tools. These tools are set up to do different functions while the raw laser beam is the same in all cases," said Mr. Bennett.

The variety of types of equipment that will go into Factory 2000 is enormous and cannot be covered in one article. This article has not even talked about the most popular factory automation products: CAD/CAM systems, which allow the designer to produce product drawings on a computerized CRT screen. CAD/CAM significantly speeds up the work of the designer and also allows him to rotate, enlarge, dissect, and even test and analyze the physical characteristics of that part he has drawn, right on the screen.

Artificial intelligence, sure to play a major role in tomorrow's factory, has not been discussed either.

"Artificial intelligence will have a major impact on CIM within this decade," asserted Richard E. Morley, director, advanced technologies, Electronic Systems Business Section, Gould Inc., Amherst, N.H. "Simply, put, artificial intelligence is the ability to take a data base, convert it by means of appropriate rules of thumb, and put it into a system that is goal-directed—in other words, data converted by rules to accomplish goals."

New metalworking machines and new materials such as composites and ceramics have not yet been mentioned, nor have new developments in sensors and quality testing. The list is too long; yet all will play important roles in the factory of the future.

What is obvious is that there is more advanced technology around than a manufacturer knows what to do with. And even more developments are just around the corner. Today, choosing to automate should not be contingent upon the appearance of some spectacular new technology that will solve all problems for a very low cost. But, U.S. manufacturers, fascinated by Star Wars technology, continue to dream.

What is needed is a realistic vision, not a dream, and some advice on the first steps to take in order to realize that vision.

STEPS TO INTEGRATION

A number of blueprints have been drawn up which outline the specific steps companies should take to construct the factory of the future. However, if a firm wants to build its Factory 2000, it should ignore these detailed automation plans for as long as possible.

A manufacturer searching for better ways to produce parts has to be very careful that he does not turn too quickly to technology for the quick fix he needs to pep up his sagging productivity. When re-evaluating company philosophy and strategies, the consideration of specific technologies should occur only very late in the process.

Before anything else, the first step toward Factory 2000 is an educational one. And who better to take that first step than the CEO.

Educating management

"Companies have got to start by educating senior management as to the strategic benefits of things like CIM, or total quality control or just-in-time manufacturing," insisted Mr. Gunn of Arthur D. Little. "There are powerful tools out there and that should be understood. Take a concept like CIM, it is a valuable tool that delivers proven strategic as well as financial benefits to the company. You simply have to make top management aware of that. And most aren't aware.

"You also have to get them thinking strategically, make them see that they can compete on their ability to engineer and manufacture products. That is the real basis of competition if you are a manufacturing company. And there are ways we can use CIM to change that basis of competition."

Hopefully, the result of taking step one will be a purging of the misconception that plant operations are pretty much a given: that materials are fed into one end and a product emerges out the other side, often late and not of the highest quality; and that nothing can change that reality. Another consequence of taking step one should be a growing awareness that to do nothing is to die. "It maybe a slow death by a 1000 cuts but death just the same," commented Mr. Gunn.

Step two toward Factory 2000 involves setting goals and devising strategies to reach those goals. In developing these strategies three questions must be answered: Where am I? Where do I have to get to? And how do I get there?

"After you set the strategic objectives and realize what you want to accomplish: like reduce new product development time by 50 pct in two years, or increase inventory turns from 5 to 25 over the next two years, you can then look at how you can achieve those things and the tools to support that," said Mr. Gunn.

However, before a company can develop specifications of how modernization is going to take place, it must do some soul searching. "The company looking toward automation really has to analyze itself. Contemplate its own navel," explained Ralph Waite, vice president and general manager, ICC Business, Allen-Bradley Systems Division, Highland Heights, Ohio. "You don't do this self-analysis by merely setting up an automation task group somewhere. You do this by having management that is in place work together defining goals."

People heavily involved in manufacturing have to be part of this discussion. And their planning should be of the top-down variety. As mentioned, discussions of specific hardware still should not bar entering the conversation.

"The goal of these planners should be to create a functional specification of how they want to run their plant, not specifications of the equipment required to do it," said Mr. Waite. "They should define the task that is to be done, not how it is to be done."

But plans cannot be finalized until management really knows what is going on in its manufacturing facility. "A plan must be developed to analyze the existing plant," said Mr. Waite. "This

Besides being exciting, the vision of your future factory should be carefully conceived, and the plans to fulfill that vision clearly spelled out. A long-range plan should start with an inventory of you current environment.

Then it would be helpful to know:what technologies you have already implemented.

is really a major task and has to be documented."

Where are we going?

This documentation is necessary because before goals can be formulated, before it can be determined where a company is going, it must be known where the company is today.

Once strategies and self-evaluations have been carried out, step three is to establish a corporate-wide culture. "Factory automation cannot occur in a vacuum," explained Mr. MacFarlane of the Gartner Group. "Without an intelligent, informed, and committed management and technical staff, factory automation techniques cannot achieve their goals no matter which implementation technique is chosen."

Step four is the development of a unified communications structure or architecture, which ensures that people in the company are all pulling in the same direction.

"Consistent with the strategy and expertise of the people involved, the central architecture of the factory automation system must be established. This prevents a series of disheartening false starts and lengthy re-implementations without appreciable productivity gain," said Mr. MacFarlane.

"We see so many firms... that encourage each division to go off and do what it wants with different systems that don't talk to each other. Some day it is going to take millions of dollars and more important: years, to correct this mistake," said Mr. Gunn.

An interesting paradox arises when companies discuss moving from basic manufacturing into high-tech production. "When the implementation of modern technology is successful, it forces companies to get back to the basics, to get together and find out what are the major problems that need solving," explained Mr. MacFarlane.

If firms build their Factory 2000 on a shaky foundation, the factory will have little chance, for if inaccurate information on what is really happening in manufacturing is fed into the computers, the result will be, as they say in Silicon Valley; garbage in, garbage out.

VISIONS OF TOMORROW

Until now, this article has examined the stepping stones to be touched on and the log jams to be dislodged before Factory 2000 can be safely reached. But before any stepping and dislodging can take place, a manufacturer must have some idea where he is going. He must have the vision of Factory 2000 before him. To help flesh out that vision, we willlook at some possible shapes of this fantasy.

One problem with many modernization efforts today is that they are fragmented. Divisions and plants within companies are going their own way. Someday all of these organizations will linked together. But as the ad says: "You can pay me now or you can pay me later." If integration is ignored now, it will be heard from at a later date. Someday, when no more options are available, companies will be forced to embrace integrated manufacturing solutions. However, the longer firms wait, the more disruptive and costly the transition will be.

According to Mr. Slautterback of Koppers, Factory 2000 will be very unlike anything we have today. Because of the need for industry to survive, to remain competitive, and because of exploding computer technology, manufacturing change over the next two decades will be rapid. Because a good deal of change could occur during the next 16 years, Factory 2000 probably will look quite different from anything we have today. Although the Japanese have already built two or three plants that are operated by only a few people.

By the time the year 2000 rolls around, "The distinctions between the process industries and discrete manufacturing; between the manufacturing of electronics and machinery; between assembly and fabrications; between engineering and manufacturing will all tend to blend (or blur) as an economic lot size of one is approached," speculated Mr. Slautterback.

More specifically, tomorrow's factory "...will have defined generic work centers depending upon the process or automation requirements," suggested Mr. Morley of Gould. "These process centers will have generic manufacturing, or certainly FMS approaches to manufacturing. Some of the processing will, of course, be robots inside each of these FMS centers. These centers will

in turn be interconnected by materials handling components such as material handlers, and intelligent vehicles and conveying systems.

Mr. Morley continued,"Robots will be used as local material handlers to put parts in and manipulate parts within these flexible machining centers. A command and control center will be used to modify, control, monitor, and in general, run the automation system of the future."

Most futurists say that tomorrow's factory will not be devoid of people. These people, however, would be performing much different jobs than factory workers today. The people primarily would be the decision makers who would use the timely decision support information prepared by computers using artificial intelligence.

"In the year 2000, computer applications will make possible the unmanned factory," said Mr. Slautterback. "The individuals remaining in manufacturing will be primarily top managers, engineers and skilled maintenance personnel. Hierarchical organizations will become obsolete, because dynamic responsiveness will be required to maintain competitive leadership. This means that organizations currently with 11 to 15 levels of employment will streamline to 4 to 7 levels. The pyramid will flatten or perhaps become diamond shaped.... It is interesting to note that over 70 pct of the jobs in the year 2000 cannot be identified or described today."

Generalist

The future employee will be a generalist, he will be cross-trained in several jobs. The staff engineer, for example, will design and instruct the manufacture of products from his graphic workstation.

"The engineer will analyze, schedule, instruct the robot, create the process plan, create the NC machining instructions, define inspection criteria, simulate the complete process, as well as many other tasks," concluded Mr. Slautterback. "He therefore will become line management. The line manager, on the other hand, will monitor the manufacturing environment for unexpected problems and become functionally staff."

Besides being exciting, the vision of your future factory should be carefully conceived, and the plans to fulfill that vision clearly spelled out. A long-range plan should start with an inventory of your current environment.

Then it would be helpful to know: what technologies you have already implemented, "The availability and status of new technologies. The logical sequence of implementation. The rate of change that your company can tolerate. The real cost and potential benefits. Who is the champion to lead each area of charge. And what is the implementation status of your global competitors," outlined Mr. Slautterback.

Despite the complicated technical tools that will be used in tomorrow's factory, operations actually will be much simpler. Already procedures have started to get simpler in a few factories.

"Parts now are being designed to be made easily; thousands of parts have been replaced by hundreds of families of parts; hundreds of machines have been replaced with several flexible manufacturing systems.

"Large inventories and long lead times have been replaced with small inventories and short lead times that are manageable; confusion created by scrap and rework has been drastically reduced; automated material handling has improved the material flow and part location; fewer employees have created less confusion; less paper has reduced transposition errors, lost copies, and filing mistakes.

"Redundancies have been eliminated; and the walls between manufacturing, engineering, marketing and finance have been replaced with one cohesive system that works: computer-integrated manufacturing," said Mr. Slautterback.

Even now far-seeing companies are taking their first tenative steps toward the 21st century. A century where the factory manager, much like the early potter, will again have integrated mind, tools and materials into an integrated operation. □

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WARNING: A COKE SHORTAGE JUST AROUND THE CORNER

There is no mystery to all of this. Since 1973 there has been a net decrease of 10 pct in steel capacity. In the same period coking capacity has declined nearly 50 pct.

BY GEORGE J. MCMANUS

"I predict there will be a coke shortage," said James T. Bradford, executive vice prsident, Jones & Laughlin Steel Corp.

"I don't think it will be until 1985," Mr. Bradford said.

Officials of Rouge Steel agreed it would be early 1985 before the domestic industry was hit by a coke pinch.

The exact timing may depend on how you define shortage. "We're into a coke shortage now in that we're rapidly consuming our stockpile," said J. Gordon Price, president of Dravo/Still, the joint venture recently formed by Dravo Engineers, Inc., and Firma Carl Still of West Germany.

"We've been sitting here waiting for this to happen," said W.D. Edgar, chief engineer of what used to be the E&C group of Koppers Co., and is now part of Raymond Kaiser Engineers, Inc.

In terms of domestic capacity, the shortfall could be said to extend back quite a while. "Because of the shortage of domestic coke," said Thomas G. Katsahnias, vice president, manufacturing, Inland Steel Co., "U. S. steelmakers, including Inland, have imported some part of their needs off and on since the late 1970's."

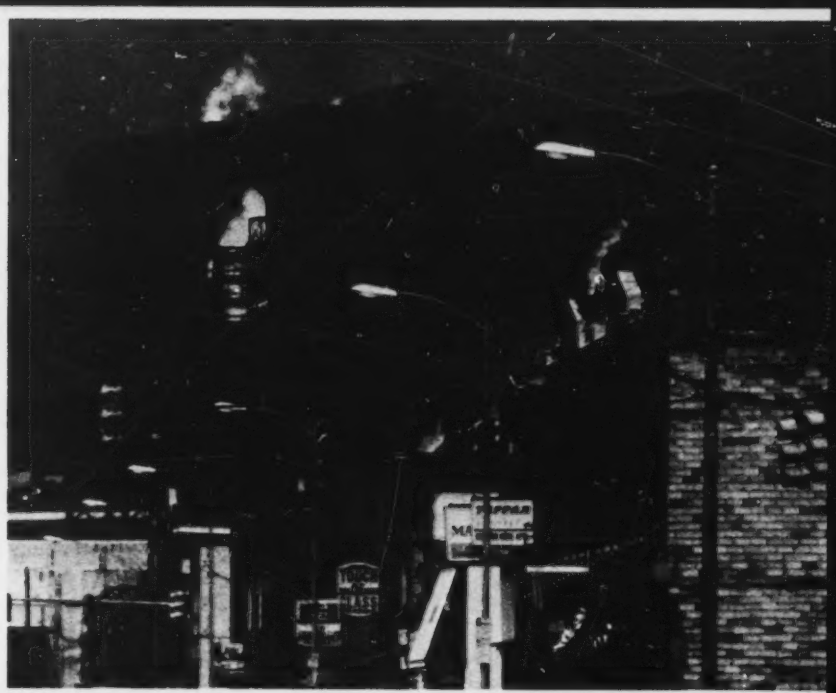
There is no mystery about all this. Since 1973, there has been a net decrease of 10 pct in steelmaking capacity. In the same period, coking capacity has declined nearly 50 pct. Only a little over 30 million tons can be produced in domestic coke ovens today.

Moreover, the remaining capacity is a source of embarrassment and distress. Much of it is represented by relatively new "tall" ovens. These aren't producing up to designed rates and they aren't standing up. Many of them have about reached the end of a life expectancy that is only 10 years.

This is a world wide problem, and may affect the availability of foreign coke. This could be critical because there is a growing reliance on imports.

Inland began talking in 120,000 tons of Japanese coke in early May. Four ocean freighters were bringing Inland 65,000 tons of Italian coke in May and August. Three ships were due to bring 45,000 tons from Britain in late June.

"These three supplies together equal about 8 pct of our total yearly coke consumption," said Mr. Katsahnias,



The recent technical history of coking has been marked by disaster and fiasco. Photo: Weirton W. Va.

A prolonged coal strike could throw a wrench into the workings of steel

Bethlehem Steel Corp. is in good shape on coke. "At 80 pct of capacity, we're probably very comfortable," said Richard O. Wenger, division manager, raw materials inventory.

Nevertheless, Mr. Wenger and Bethlehem have a few worries.

"The thing that could screw it all up would be a very long coal strike," said Mr. Wenger.

Coal contracts expire the end of September. A coal strike deadline is always serious for steel producers, but there is special concern this year.

"Business is finally picking up a little bit," said Mr. Wenger. "I'd hate to see that get messed up because we ran out of raw materials."

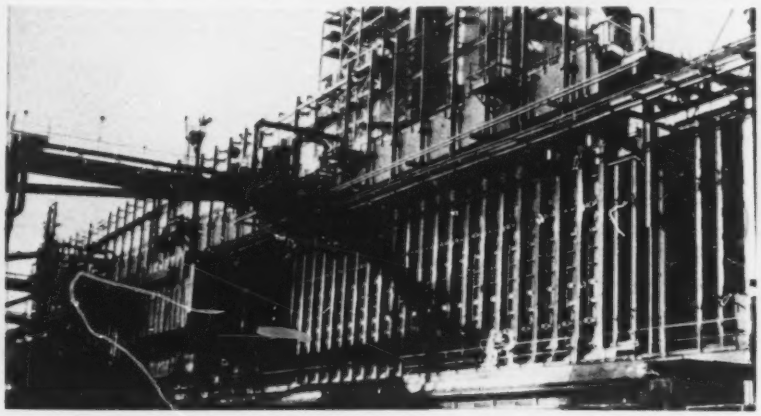
Another concern is "the fact that there is new leadership in United Mineworkers. That always raises questions about what to expect."

Looking down the road, Mr. Wenger wonders about the cost of providing coke capacity. "The cost of new coke batteries has gotten up to the point where it would take away from a lot of other things we should be doing in the steelmaking plants."

An estimate of $200 million as the cost of a big new battery could be conservative, he said.

Future supply could also be affected by the early failures of the newer, tall batteries. "I'm concerned with it on the basis of how reliable the supply will be over the years," said Mr. Wenger.

The situation on one tall battery has reached the stage of legal action. Questions on this drew only a terse statement. "Bethlehem is engaged in litigation concerning the Sparrows Point A battery with McKee Otto."



The shortage of domestic coke has led some steel producers to import some part of their need. Photo: Inland Steel Co., coke battery No. 11.

"and they are being purchased because we can't fill our needs internally."

National Steel Corp. has 1.4 million tons of coking capacity and a requirement for 2 million tons. This difference is being made up with purchased coke, domestic and foreign.

"Right now, we're about 50-50," said Vaughn Knapp, director of raw materials for National Steel.

Rouge Steel is buying coke from New Boston Coke Corp. in Portsmouth, Ohio. The Portsmouth ovens were formerly owned by McLouth Steel Corp. McLouth now relies entirely on purchased coke. The same is true of Weirton Steel Corp. and Sharon Steel Corp.

Coke Imports

The coke outlook was assessed in late 1983 by Milton Deaner, president of McLouth. "If you say we're going to hit 78 million tons in 1984," said Mr. Deaner, "I say we'll import coke to do so." (*Iron Age*, Jan.2, 1984). He wasn't sure there would be much foreign coke available.

Another warning came from Vincent Sekela, executive vice president of Krupp Willputte Corp. "We predicted there would be a shortage when the industry got above 80 pct," said Mr. Sekela. "We think there's going to be a drastic shortage in May," he added.

In March, steel operations went over 80 pct. Shipments, on an annual basis, went well over 78 million tons. "If we maintain this rate, we're going to be out of coke in a few months," said W.T. Hogan of Fordham University.

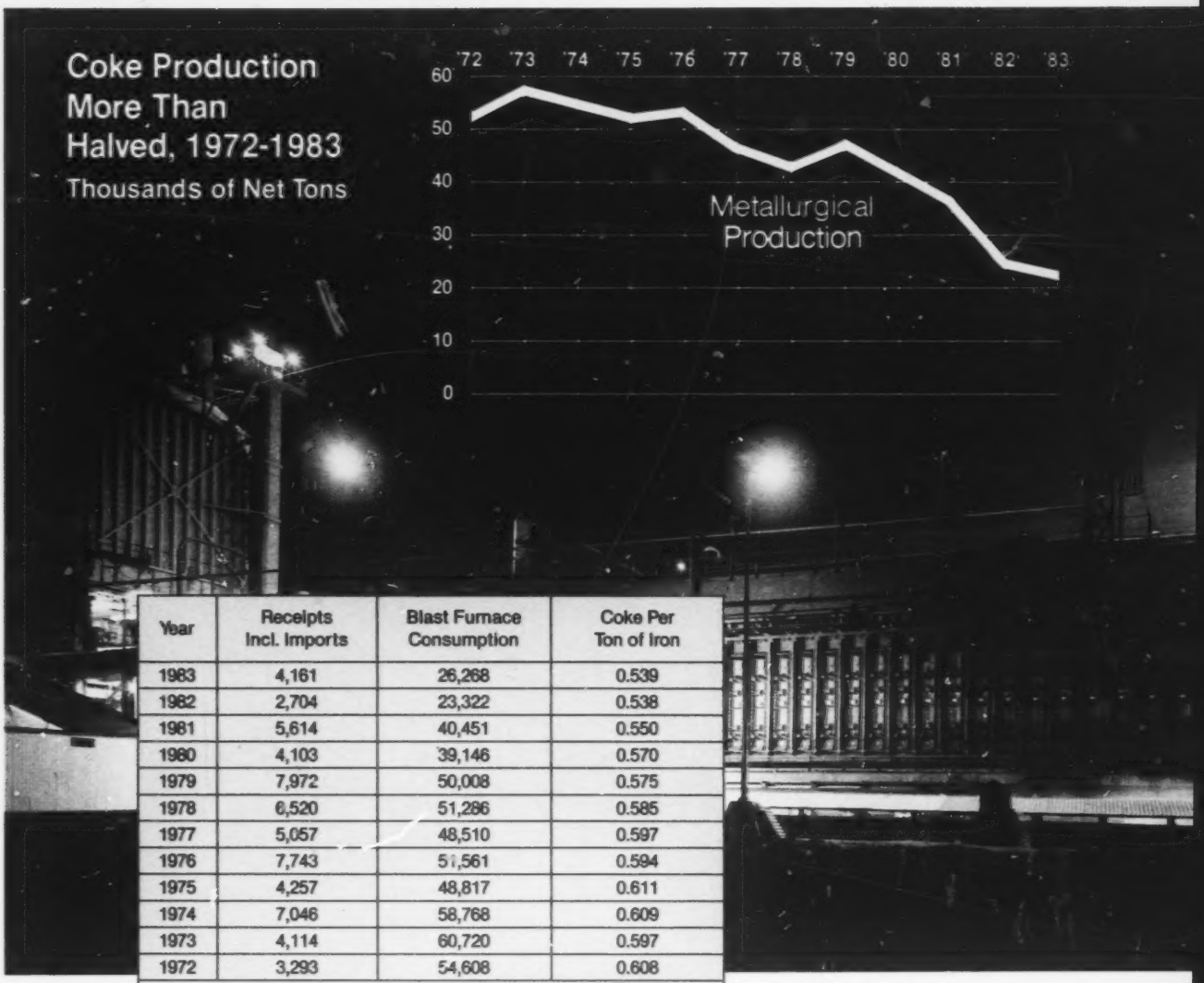
In explaining its use of imported coke, Inland implied that the domestic merchant supply had pretty well been exhausted. "Over the long haul, we prefer to fill our coke shortfall through some domestic sources," said Mr. Katsahnias. Imported coke is subject to deterioration and involves complex logistics, he said. Inland wouldn't be importing, obviously, if domestic coke were available.

"It may be running dry," said Mr. Knapp of the domestic supply, "but here and there, there are still some opportunities. I think some of the merchant producers have price ideas that are outside of the market."

As of mid-May, merchant coke was delivering for around $100 a ton. The Japanese were selling aggressively, and domestic suppliers were reportedly waiting for more favorable terms.

There is a fairly large merchant coke supply. In 1983, over 4 million tons of coke were purchased. Portions of this could be coming from captive ovens of the big mills. United States Steel Corp. reportedly has excess capacity at Clairton, Pa. Bethlehem Steel Corp. has over 1 million tons of coking capacity at Lackawanna, N. Y.

Weirton Steel has lined up domestic sources. "I've been able to get firm commitments for the next three years," said Malcolm A. Wilkinson, vice president, purchases and traffic.



Year	Receipts Incl. Imports	Blast Furnace Consumption	Coke Per Ton of Iron
1983	4,161	26,268	0.539
1982	2,704	23,322	0.538
1981	5,614	40,451	0.550
1980	4,103	39,146	0.570
1979	7,972	50,008	0.575
1978	6,520	51,286	0.585
1977	5,057	48,510	0.597
1976	7,743	51,561	0.594
1975	4,257	48,817	0.611
1974	7,046	58,768	0.609
1973	4,114	60,720	0.597
1972	3,293	54,608	0.608

Source: AISI

Mr. Wilkinson looked for further shrinkage of the domestic coke supply but he didn't expect a global crunch. "Coke will probably be available world wide," he said.

Coking capacity was one consideration in the merger of Jones & Laughlin Steel Corp. and Republic Steel Corp. "Republic is in a good coke position," said Mr. Bradford. There are new batteries in Chicago-Warren, he noted. "J&L and Republic will be in a pretty good position."

There hasn't been a good test of the foreign coke supply for some time. During the slack times of 1982 and 1983, almost no coke was imported. According to the Commerce Department, only 34,000 tons entered the U.S. in 1982.

Since the start of 1984, imports have spurted. Over 70,000 tons of coke entered the U.S. in January and more than 100,000 tons in February. The big source has been Japan, which accounted for 77,000 tons in February. It is something of a paradox that Japan, which is a fuel have-not, should be supplying coke to the U.S., which has abundant coal reserves.

There is probably some surplus coke in Europe. In the last import crunch, most of the foreign coke came from West Germany. That country provided 4 million out of the 5.7 million tons imported in 1978.

The Germans are said to be sitting on a 20-million-ton coke stockpile now. As of May, none of this was being of-

fered for export. Higher prices will be needed to bring out the German coke, said one buyer.

Shortfall

The domestic deficits are partly a matter of new management strategy. "There was a point in time when we thought as an integrated steelmaker we ought to be close to 100 pct in all of our raw material needs," said Mr. Knapp. "I don't think we have that same thinking any more."

The mills did some new thinking when they found themselves locked into huge iron ore commitments. And the economics of coke oven construction are very unattractive. A 1-million-ton battery can run about $200 million. For a little over $200 million, National was able to buy United Financial of California in 1979.

Apart from cost, the recent technical history of coking has been marked by disaster and fiasco. It has proved almost impossible to make coke efficiently while complying with government regulations.

To control pushing emissions, a plants tried putting sheds or canopies over the ovens. They did a good job of containing dust, but drew complaints from unions and health regulators.

The mills then went to quench cars with various scrubbing systems. There were maintenance problems and high energy costs, and operators are coming back to stationary systems.

"I think most people are leaning toward sheds now," said Mr. Edgar of Raymond Kaiser.

Inland's situation brings out the extent of technical headaches. In 1983, Inland shut down C battery. This had the capacity to produce over 470,000 tons a year.

C Battery wasn't old; it was started in August of 1974. The life of the short ovens is 37 years. Nevertheless, C battery had deteriorated to the point where a shutdown was necessary.

The alternative was a complete rebuild at a cost of millions. "And even if funds were available to start a rebuild, it couldn't be in production before late 1986 or early 1987 period," said Mr. Katsahnias.

Some of C battery's problems came from Inland's pioneering of pipeline charging and coke pre-heating. The pipeline concept seemed the ideal answer to charging emissions. It may prove to be so, but Inland had all kinds of trouble with C battery. A second pipeline application by the company has been much more satisfactory.

Domestic steel mills are doing some stockpiling but the last two coal strikes had little impact on steel operations.

There were special problems with the first pipeline, but C battery also shared in the general problems of the tall ovens. Starting in the late Sixties, North American mills began building coke batteries that were 5 meters or more in height.

These were designed to produce coke in about 12 hours. It turned out that there were problems with stack emissions, door leaks, and wall cracks. It proved impractical to maintain the short coking cycles.

"People have backed off on operating rates," said Mr. Edgar.

As a result, most of the tall batteries are performing well below their designed capacities. Annual output in typical installations is running 200,000 to 300,000 tons below the expected rate.

Premature Failure

In addition, the tall ovens have been subject to premature failure. The older, short ovens are lasting 35 years. The earlier tall ovens are given a life expectancy of 10 years. The late models are expected to last 18 years.

In a group of 25 tall ovens, five are down or have had to have major rebuilding. It's possible ways will be found to improve production rates and life spans; a great deal of work is being done on the tall batteries; but they remain a worry in the coke situation.

No one seems too concerned about the possibility of a coal strike Sept. 30. Domestic mills are doing some stockpiling but the last two coal strikes had little effect on steel operations or anything else. Officials of United Mineworkers of America have indicated they may try selective strikes this time.

Underway in May were a British coal strike and a German metals strike. Coming up was the deadline for a possible auto strike in the U.S. ☐

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PRICE & PRODUCTION DATA

(Effective May 21, 1984)

Steel production by districts, thousands of tons (000 omitted)

	Last Week	Two Weeks Ago	Month Ago	Year Ago
North East Coast	254	247	267	188
Buffalo	11	12	11	32
Pittsburgh	301	298	292	195
Youngstown	97	102	118	102
Cleveland	147	155	147	134
Detroit	185	174	186	140
Chicago	578	581	577	490
Cincinnati	130	124	121	91
St. Louis	91	89	85	75
Southern	232	238	233	143
Western	90	90	90	107
U.S. Production	2,116	2,110	2,127	1,697

Source: American Iron & Steel Institute

Lake Superior Ore Prices

51.50% Fe Natural delivered lower Lake ports. Rail transportation, handling and unloading may be charged to the account of the buyer. Coarse ore 80¢ premium.

Pellets (per iron unit natural).....gross-ton 80.50-86.9*
Mesabi, regular-unscreened .....gross-ton $32.53
Mesabi, non-bessemer.....gross-ton $30.03-31.53**

*80.50¢—Pickands Mather as of 1/27/81.
86.9¢—U. S. Steel as of 3/15/82. Cleveland-Cliffs as of 2/26/82, Oglebay Norton as of 3/25/82, and Hanna Mining as of 2/26/82.
**Effective 8/1/83.

STEEL PRODUCTION, COMPOSITE PRICES

(Effective May 21, 1984)

U.S. Steel Production	Last Week	Two Weeks Ago	To Date 1984	To Date 1983
Net tons, in thousands	2,116	2,110	39,749	30,273
Capability Utilization Rate	81.5	81.2	76.8	52.3

Composite Prices	This Week	Week Ago	Month Ago	Year Ago
Finished Steel Base* (¢/lb.—eff. 5/14/84)	27.405	27.405	26.939	26.217
Pig Iron* * (Net ton = 2000 lbs.)	$213.00	$213.00	$213.00	$213.00
Scrap No. 1 hvy.* * * (Gross ton = 2240 lbs.)	$ 89.50	$ 89.50	$ 90.17	$ 67.50
No. 2 bundles	$ 60.17	$ 60.17	$ 60.83	$ 46.50

Scrap Comparison (Gross Ton)

No. 1 steel, Pittsburgh..	$100.50	$100.50	$100.50	$ 68.50
No. 1 steel, Philadelphia ..	82.50	82.50	84.50	66.50
No. 1 steel, Chicago.....	85.50	85.50	85.50	67.50
No. 1 bundles, Detroit	92.50	92.50	89.50	69.50
Low Phos., Youngstown ..	98.50	98.50	96.50	71.50
No. 1 mach'y cast., Pgh...	79.50	79.50	79.50	74.50
No. 1 mach'y cast., Phila	100.50	100.50	100.50	98.50
No. 1 mach'y cast., Chi..	117.50	117.50	117.50	106.50

*Finished Steel Composite: Weighted index of steel bars, shapes, plates, wire, rails, black pipe, hot and cold rolled sheets and strips.
* *Pig Iron Composite: Based on average prices for basic and foundry pig iron at representative producing points within the U.S.
* * *Steel Scrap Composite: Average of No. 1 hvy. melting steel scrap and No. 2 bundles delivered to consumers at Pittsburgh, Philadelphia and Chicago.

NONFERROUS PRICES

(Effective May 21, 1984) Prices obtained in trade based on representative tonnages per gross ton delivered to consumer unless otherwise stated

Primary Metal Prices

(cents per lb.)	current price	last price	date of change
Aluminum	81.00	76.00-81.00	9/27/83
Copper (C)	68.00-69.00	69.00	5/15/84
Lead	25.00-28.00	26.00-28.00	5/3/84
Magnesium Ingot	143.00	138.00	1/3/84
Nickel	329.00	350.00	11/25/81
Titanium Sponge	555.00-585.00	555.00	4/29/82
Zinc	52.00-53.00	53.00	5/3/84

ALUMINUM: 99.5%. COPPER (C) = cathode. LEAD: common grade. MAGNESIUM: 99.8% pig, delivered. NICKEL: electro., Port Colborne, Canada. ZINC: high grade.

Antimony, American Laredo, Texas	$2.00
Beryllium-aluminum 5% Be, per lb. contained Be	$215.00
Beryllium-copper, per lb. cont. Be	$130.00
Beryllium 97% powder 200	$178.00
Bismuth, ton lots	$1.65-$1.80
Cadmium, ton lots	$2.25
Calcium, ton lots, crown	$3.58
Chromium, 99.8%	$3.75
Cobalt, 99%, cathode	$12.50
Gold per troy oz.	$380.75
Indium, dollars per troy oz.	$2.50-$3.60
Iridium, dollars per troy oz.	$600
Magnesium sticks, 10,000 lbs.	$1.97
Mercury, per 76-lb. f.o.b. N.Y.	$325-$335
Molybdenum, lb. tech. moly oxides, 20 lb. MO can	$6.85
Nickel oxide sinter at U.S. points of entry	$3.12
Palladium, per troy oz.	$140
Platinum, per troy oz.	$475
Rhodium, per troy oz.	$600.00
Silver ingots, per troy oz.	$8.99
Vanadium	$6.00
Zirconium sponge	$12.00-$17.00

(Per lb. unless otherwise noted)

Straits Tin Price

(U.S. cents per lb, EX-SMELTER, based on daily market in Penang in Malaysian dollars per kilo.)

May 14—573.85 May 17—573.85
May 15—573.72 May 18—567.24
May 16—573.98

Scrap Prices
Brass Mill Scrap

(Cents per lb; over 20,000 lbs. add 1¢ per lb)

	Solids	Turning
Copper	64⅛	63
Yellow brass	59⅜	59
Red brass	61¼	60
Comm. bronze	62⅛	60¼
Mang. bronze	62¼	53½
Free cutting rod ends	60	59

Custom Smelters Scrap

(Cents per lb., carload lots, del. refinery)

No. 1 copper wire	60
No. 2 copper wire	51
Light copper	42

Ingot Makers Scrap

(Cents per lb., carload lots, del. refinery)

No. 1 copper wire	56
No. 2 copper wire	47
Light copper	38
No. 1 composition	57
No. 1 comp. turnings	56
Hvy. yellow brass solids	38
Hvy. yellow brass turnings	36
Radiators	47

Aluminum

New mixed clips	46	—47
Old sheet	44	—45
Old cast	44	—45
Clean dry borings	45	—46

Dealers' Scrap

(Dealers' buying price f.o.b. New York in cents per pound)

Aluminum

Segregated clippings	41	—42
Mixed L.C. clips	38	—40
Old sheets and cast	34	—35
Borings and turnings	26	—28
Duraluminum clippings	27	—28

Copper and Brass

No. 1 copper wire	51	—52
No. 2 copper wire	42	—43
Light copper	37	—38
Radiators	35	—36
No. 1 composition	45	—46
No. 1 composition turn'gs	42	—43
Cocks and faucets	31	—32
Clean heavy yellow brass	29	—30
Brass Pipe	30	—31
New soft brass clippings	46	—47

Lead

Heavy soft lead	9	—10
Whole batteries	3	— 4
Type metal	15	—16
Electrotype	13	—14

Nickel

Nickel solids	120	—130
Nickel rod ends	120	—130
Nickel sheets, clips	120	—130
Nickel turnings	60	— 70

Zinc

New zinc clippings	18	— 19
Old diecast zinc	13	— 14

EFFECTIVE MAY 21, 1984

(Effective May 21, 1984) Prices obtained in trade based on representative tonnages per gross ton delivered to consumer unless otherwise stated. Prices are the opinions of *Iron Age* editors and correspondents, based on contacts with dealers, brokers, generators and users in the industry on the effective date listed above.

Ferrous Scrap Prices

Pittsburgh

No. 1 hvy. melting	$100.00 to $101.00
No. 2 hvy. melting	90.00 to 91.00
No. 1 dealer bundles	118.00 to 119.00
No. 1 factory bundles (auto)	119.00 to 120.00
No. 2 bundles	59.00 to 60.00
No. 1 busheling	117.00 to 118.00
Machine shop turn	16.00 to 17.00
Shoveling turnings	54.00 to 55.00
Cast iron borings	53.00 to 54.00
Low phos. punchings plate	119.00 to 120.00
Heavy turnings	90.00 to 91.00
No. 1 RR hvy. melting	113.00 to 114.00
Rails 2 ft. and under	125.00 to 126.00
Scrap rails, random lgth	109.00 to 110.00
RR specialties	124.00 to 125.00
No. 1 machinery cast	79.00 to 80.00
Cupola cast	72.00 to 73.00
Heavy breakable cast	30.00 to 31.00
Stainless	
18-8 bundles and solids	600.00 to 610.00
18-8 turnings	500.00 to 510.00

Chicago

No. 1 hvy. melting	$ 85.00 to $ 86.00
No. 2 hvy. melting	81.00 to 82.00
No. 1 dealer bundles	116.00 to 117.00
No. 1 factory bundles (auto)	116.00 to 117.00
No. 2 dealer bundles	64.00 to 65.00
No. 1 busheling	107.00 to 108.00
Shredder scrap	103.00 to 104.00
Machine shop turn	46.00 to 47.00
Mixed bor. and turn	47.00 to 48.00
Shoveling turnings	56.00 to 57.00
Cast iron borings	57.00 to 58.00
Low phos. forge crop	122.00 to 123.00
Low phos. punchings plate ¼ in. and heavier	132.00 to 133.00
Low phos. 2 ft. and under	127.00 to 128.00
No. 1 RR hvy. melting	107.00 to 108.00
Scrap rails, random lgth.	107.00 to 108.00
Reroller rails	112.00 to 113.00
Rails, 2 ft. and under	126.00 to 127.00
RR couplers and knuckles	110.00 to 111.00
RR car axles	134.00 to 135.00
No. 1 machinery cast	117.00 to 118.00
Cupola cast	108.00 to 109.00
Stove plate	106.00 to 107.00
Steel car wheels	120.00 to 121.00
Stainless	
18-8 bundles and solids	555.00 to 565.00
18-8 turnings	455.00 to 465.00
430 bundles and solids	135.00 to 140.00
430 turnings	100.00 to 105.00

Philadelphia

No. 1 hvy. melting	$ 81.00 to $ 84.00
No. 2 hvy. melting	71.00 to 74.00
No. 1 dealer bundles	103.00 to 106.00
No. 2 dealer bundles	55.00 to 58.00
No. 1 busheling	104.00 to 107.00
Shredder scrap	97.00 to 100.00
Machine shop turn	29.00 to 32.00
Mixed bor. and turn	29.00 to 32.00
Shoveling turnings	47.00 to 50.00
Low phos. 5 ft. and under	102.00 to 105.00
Low phos. 2 ft. punchings	120.00 to 123.00
Electric furnace bundles	114.00 to 117.00
RR specialties	106.00 to 109.00
Rails, 2 ft. and under	120.00 to 123.00
Cupola cast	72.00 to 75.00
Heavy breakable cast	57.00 to 60.00
No. 1 machinery cast	99.00 to 102.00

Detroit

Broker buying prices per gross ton on cars:

No. 1 hvy. melting	$ 65.00 to $ 66.00
No. 2 hvy. melting	62.00 to 63.00
No. 1 dealer bundles	92.00 to 93.00
No. 2 bundles	44.00 to 45.00
No. 1 busheling	91.00 to 92.00
Drop forge flashings	62.00 to 63.00
Machine shop turn	47.00 to 48.00
Mixed borings and turn	28.00 to 29.00
Shoveling turnings	48.00 to 49.00
Cast iron borings	46.00 to 47.00
Heavy breakable cast	38.00 to 39.00
Mixed cupola cast	54.00 to 55.00
Automobile cast	77.00 to 78.00
Stainless	
18-8 bundles and solids	475.00 to 485.00
18-8 turnings	375.00 to 385.00
430 bundles and solids	120.00 to 130.00

Youngstown

No. 1 hvy. melting	$ 85.00 to $ 88.00
No. 2 hvy. melting	67.00 to 70.00
No. 1 dealer bundles	100.00 to 103.00
No. 2 dealer bundles	37.00 to 40.00
Machine shop turn	14.00 to 17.00
Shoveling turnings	19.00 to 22.00
Low phos. plate	97.00 to 100.00
Electric furnace bundles	93.00 to 97.00
Galvanized bundles	86.00 to 89.00

Cleveland

No. 1 hvy. melting	$ 76.00 to $ 79.00
No. 2 hvy. melting	50.00 to 53.00
No. 1 dealer bundles	97.00 to 100.00
No. 1 factory bundles	97.00 to 100.00
No. 2 bundles	30.00 to 33.00
No. 1 busheling	95.00 to 98.00
Machine shop turn	13.00 to 16.00
Mixed bor. and turn	13.00 to 16.00
Shoveling turnings	15.00 to 18.00
Cast iron borings	18.00 to 21.00
Cut structural & plates, 2 ft. and under	122.00 to 125.00
Low phos. punchings plate	122.00 to 125.00
Drop forge flashings	62.00 to 65.00
Foundry steel, 2 ft. & under	70.00 to 75.00
No. 1 RR hvy melting	87.00 to 90.00
Rails, 2 ft. and under	122.00 to 125.00
Rails, 18 in. and under	123.00 to 126.00
Steel axle turnings	67.00 to 70.00
Railroad cast	100.00 to 103.00
No. 1 machinery cast	109.00 to 112.00
Cupola cast	63.00 to 66.00
Stove plate	48.00 to 51.00
Stainless	
18-8 bundles	375.00 to 385.00
18-8 turnings	325.00 to 335.00
430 bundles	80.00 to 85.00

Buffalo

Broker buying prices per gross ton on cars:

No. 1 hvy. melting	$ 76.00 to $ 77.00
No. 2 hvy. melting	63.00 to 64.00
No. 1 busheling	89.00 to 90.00
No. 1 dealer bundles	89.00 to 90.00
No. 2 bundles	40.00 to 41.00
Machine shop turn	15.00 to 16.00
Mixed bor. and turn	13.00 to 14.00
Shoveling turnings	20.00 to 21.00
Cast iron borings	25.00 to 26.00
Low phos. plate	102.00 to 103.00
Structural and plate, 2 ft. and under	102.00 to 103.00
Rails, 2 ft. and under	97.00 to 98.00
Scrap rails, random lgth.	77.00 to 78.00
No. 1 machinery cast	79.00 to 80.00
No. 1 cupola cast	59.00 to 60.00

St. Louis

No. 1 hvy. melting	$ 78.00 to $ 79.00
No. 2 hvy. melting	67.00 to 68.00
Foundry steel, 2 ft.	71.00 to 72.00
No. 1 dealer bundles	78.00 to 79.00
No. 2 bundles	65.00 to 66.00
Machine shop turn	22.00 to 23.00
Shoveling turnings	29.00 to 30.00
Cast iron borings	33.00 to 34.00
No. 1 RR hvy. melting	84.00 to 85.00
Rails, random length	82.00 to 83.00
Rails, 18 in. and under	94.00 to 95.00
RR specialties	92.00 to 93.00
Cupola cast	74.00 to 75.00
Heavy breakable cast	53.00 to 54.00
Stove plate	88.00 to 89.00
Cast iron car wheels	57.00 to 58.00
Rerolling rails	90.00 to 91.00
Unstripped motor blocks	61.00 to 62.00

Birmingham

No. 1 heavy melting	$ 82.00 to $ 83.00
No. 2 heavy melting	76.00 to 77.00
No. 1 dealer bundles	82.00 to 83.00
No. 2 bundles	57.00 to 58.00
No. 1 busheling	82.00 to 83.00
Shredder scrap	104.00 to 105.00
Machine shop. turn	41.00 to 42.00
Shoveling turnings	50.00 to 51.00
Cast iron borings	50.00 to 51.00
Electric furnace bundles	75.00 to 76.00
Elec. furnace, 3 ft. & under	80.00 to 81.00
Structural and plate, 2 ft.	108.00 to 109.00
Structural and plate, 4 ft.	102.00 to 103.00
No. 1 RR hvy. melting	102.00 to 103.00
Scrap rails, random lgth.	95.00 to 96.00
Rails, 2 ft. and under	110.00 to 111.00
No. 1 cupola cast	102.00 to 103.00
Angles and splice bars	94.00 to 95.00
Unstripped motor blocks	74.00 to 75.00

Cincinnati

Brokers buying prices per gross ton on cars:

No. 1 hvy. melting	$ 70.00 to $ 71.00
No. 2 hvy. melting	84.00 to 85.00
No. 1 dealer bundles	83.00 to 84.00
No. 2 bundles	41.00 to 42.00
Machine shop turn	10.00 to 11.00
Shoveling turnings	12.00 to 13.00
Cast iron borings	27.00 to 28.00
Low phos. 18 in. and under	102.00 to 103.00
Rails, random length	83.00 to 84.00
Rails, 2 ft. and under	98.00 to 99.00
No. 1 cupola cast	72.00 to 73.00
Heavy breakable cast	37.00 to 38.00
Drop broken cast	89.00 to 90.00

New York

Brokers buying prices per gross ton on cars:

No. 1 hvy. melting	$ 50.00 to $ 52.00
No. 2 hvy. melting	41.00 to 43.00
No. 2 dealer bundles	23.00 to 27.00
Mixed bor. and turn	11.00 to 13.00
Machine shop turn	6.00 to 7.00
Shoveling turnings	14.00 to 15.00
Clean cast, chem. borings	35.00 to 36.00
No. 1 machinery cast	89.00 to 90.00
Mixed yard cast	50.00 to 51.00
Heavy breakable cast	10.00 to 12.00
Stainless	
18-8 prepared solids	510.00 to 530.00
18-8 turnings	410.00 to 430.00
430 prepared solids	90.00 to 110.00
410 solids	80.00 to 90.00

Boston

Brokers buying prices per gross ton on cars:

No. 1 hvy. melting	$ 68.00 to $ 70.00
No. 2 hvy. melting	58.00 to 60.00
No. 1 dealer bundles	75.00 to 77.00
No. 2 bundles	39.00 to 41.00
No. 1 busheling	81.00 to 83.00
Shredder scrap	73.00 to 75.00
Machine shop turn	14.00 to 16.00
Shoveling turnings	20.00 to 22.00
No. 1 machinery cast	90.00 to 95.00
Mixed cupola cast	48.00 to 50.00
Heavy breakable cast	18.00 to 20.00

San Francisco

No. 1 hvy. melting	$ 45.00 to $ 47.00
No. 2 hvy. melting	39.00 to 41.00
No. 1 dealer bundles	35.00 to 37.00
No. 2 dealer bundles	17.00 to 19.00
Machine shop turn	6.00 to 8.00
Cast iron borings	6.00 to 8.00
No. 1 cupola cast	83.00 to 85.00

Los Angeles

No. 1 hvy. melting	$ 46.00 to $ 48.00
No. 2 hvy. melting	39.00 to 41.00
No. 1 dealer bundles	36.00 to 38.00
No. 2 dealer bundles	17.00 to 19.00
Machine shop turn	10.00 to 12.00
Shoveling turnings	8.00 to 10.00
Cast iron borings	6.00 to 8.00
Elec. furnace, 1 ft. and under (foundry)	77.00 to 79.00
No. 1 cupola cast	77.00 to 79.00

Seattle

No. 1 hvy. melting	$ 71.00 to $ 73.00
No. 2 hvy. melting	60.00 to 62.00
No. 2 bundles	42.00 to 44.00
No. 1 cupola cast	98.00 to 100.00
Mixed yard cast	85.00 to 87.00

Hamilton, Ont.

Brokers buying price per net ton on cars:

No. 1 heavy melting	$ 90.00
No. 2 heavy melting cut 2 ft. and under	87.00
No. 1 dealer bundles	87.00
No. 2 bundles	48.00
Mixed steel scrap	59.00
Bush. new fact. prep'd.	85.00
Bush. new fact. unprp'd.	75.00
Machine shop turn	45.00
Short steel turn	43.00
Mixed bor. and turn	30.00
Cast scrap	73.00

Houston

Brokers buying prices per gross ton on cars:

No. 1 hvy. melting	$ 81.00 to $ 82.00
No. 2 hvy. melting	67.00 to 68.00
No. 2 bundles	44.00 to 45.00
Machine shop turn	18.00 to 19.00
Crushed turnings	42.00 to 43.00
Shredder scrap	83.00 to 84.00
Cut structural plate, 2 ft. and under	103.00 to 105.00
Cut structural plate, 5 ft. and under	95.00 to 97.00
Unstripped motor blocks	80.00 to 81.00
Cupola cast	80.00 to 81.00

PRODUCER KEY
With Principal Offices

A4 American Cladmetals Co., Carnegie, Pa.
A7 Armco Inc., Middletown, Ohio
A8 Atlantic Steel Co., Atlanta, Ga.
A11 Atlantic Wire Co., Branford, Conn.

B1 Baron Drawn Steel Corp., Toledo, Ohio
B3 Bethlehem Steel Corp., Bethlehem, Pa.
B4 Blair Strip Steel Co., New Castle, Pa.
B5 Bliss & Laughlin Steel Co., Harvey, Ill.

C1 Calstrip Corp., Los Angeles
C6 CF&I Steel Corp., Pueblo, Colo.
C10 Copperweld Steel Co., Warren, Ohio
C11 Crucible Divisions, Colt Industries, Pittsburgh, Pa.
C15 G. O. Carlson, Inc., Thorndale, Pa.
C16 Connors Steel Co., Birmingham, Ala.
C20 Calumet Steel Div., Chicago Heights, Ill.
C21 Cumberland Steel Co., Cumberland, Md.

D1 Detroit Strip Div., Cyclops Corp.
D2 Driver Wilbur B., Co., Newark, N. J.
D3 Driver Harris Co., Harrison, N. J.

E3 Enamel Products & Plating Co., McKeesport, Pa.
E4 Elliot Bros. Steel Co., New Castle, Pa.

F1 Firth Sterling, Inc., McKeesport, Pa.

G2 Granite City Steel Co., Granite City, Ill.
G3 Great Lakes Steel Division, National Steel Corp., Ecorse, Mich.
G4 Greer Steel Co., Dover, O.
G5 Green River Steel Corp., Owensboro, Ky.
G6 Gibraltar Steel Corp., Buffalo, N. Y.
G7 Georgetown Steel Corp., Georgetown, S. C.
G8 Guterl Special Steel Corp.

H1 Hercules Drawn Steel Corp., Livonia, Mich.

I2 Ingersoll Steel Div., New Castle, Ind.
I3 Inland Steel Co., Chicago, Ill.
I4 Interlake Steel Corp., Chicago

J2 Jessop Steel Corp., Washington, Pa.
J3 Jones & Laughlin Steel Corp., Pittsburgh
J4 Joslyn Mfg. & Supply Co., Chicago
J5 Judson Steel Corp., Emeryville, Calif.

K2 Keystone Consolidated Industries, Inc.
K3 Kentucky Electric Steel Co., Ashland, Kentucky
K5 Kemco Div., Foote Mineral Co., Keokuk, Iowa

L2 La Salle Steel Co., Chicago
L3 Lone Star Steel Co., Dallas
L4 Lukens Steel Co., Coatesville, Pa.
L5 Litho-Strip Corp., Chicago

M2 McLouth Steel Products Corp.
M4 Mid States Steel & Wire Co., Crawfordsville, Ind.
M8 Mill Strip Products Div., National Steel Service Center, National Steel Corp.
M9 Moltrup Steel Products Co., Beaver Falls, Pa.
M11 Midwest Steel Div., National Steel Corp., Portage, Ind.

N1 Northeast Precision Steel Co., Boston, Mass.
N4 Northwestern Steel & Wire Co., Sterling, Ill.
N6 Northwest Steel Rolling Mills, Seattle, Wash.
N9 Nelsen Steel & Wire Co., Chicago, Ill.
N10 North Star Steel Co., Saint Paul, Minnesota

O2 Oregon Steel Mills, Portland, Ore.

P2 Phoenix Steel Corp., Claymont, Del.
P9 Pacific States Steel Co., Niles, Cal
P14 Pacific Tube Co., Los Angeles
P15 Philadelphia Steel and Wire Corp., Phila.

R3 Republic Steel Corp., Cleveland
R4 Ramco Steel Co., Buffalo, N. Y.
R5 Roblin Steel Corp., Inc., North Tonawanda, N. Y.
R6 Rodney Metals, Inc., New Bedford, Mass.
R7 Rome Strip Steel Co., Rome, N. Y.

S1 Sharon Steel Corp., Sharon, Pa.
S7 Stanley Works, New Britain, Conn.
S8 Superior Drawn Steel Co., Monaca, Pa.
S10 Seneca Steel Service, Buffalo, N. Y.
S16 Southern Precision Steel Co., Gulfport, Miss.

T4 Thomas Steel Strip Co., Warren, O.
T5 Timken Company, Steel Division, Canton, O.
T7 Texas Steel Co., Fort Worth, Tex.
T9 Triumph Electro Corp., Chicago, Ill.
T10 Tennessee Forging Steel Corp., Harriman, Tenn.
T11 Teledyne Columbia-Summerill, Carnegie, Pa.

U1 United States Steel Corp., Pittsburgh, Pa.

W3 Weirton Steel Corp., Weirton, West Va.
W5 Wheeling-Pittsburgh Steel Corp.
W7 Wilson Steel & Wire Co., Chicago
W10 Wyckoff Steel Div., Ampco-Pittsburgh Corp., Pittsburgh, Pa.
W14 Whittaker Steel Strip Div., Detroit, Mich.

STEEL SERVICE CENTER PRICES

Price, Dollars per 100 lb

Prices are based on list prices reported to *Iron Age* by a number of metal service centers deemed representative by *Iron Age* and then weighted based in part on the reports received each month. Prices are not intended to reflect the actual transaction prices obtained by any individual metal service center.

Cities*	Sheets			Strip	Plates	Shapes	Bars		Alloy Bars			
City Delivery Charge*	Hot-Rolled (10 gage)	Cold-Rolled (20 gage)	Galvanized (16 gage)	Hot-Rolled Strip	Plates	Standard Structurals	Hot-Rolled (merchant)	Cold Finished	Hot-Rolled 8620 As Rolled	Hot-Rolled 4140 Annealed	Cold-Drawn 8620 As Rolled	Cold-Drawn 4140 Annealed
Atlanta	26.26	33.90	33.70	31.00	25.83	22.67	19.31	31.54	34.34	50.60	69.58	73.19
Baltimore	26.28	30.72	37.59	36.83	33.68	28.80	22.05	37.10	57.45	64.70	71.71	77.05
Birmingham	24.03	31.90	32.34	30.92	25.55	23.01	19.58	29.68	49.31	58.90	68.10	74.43
Boston	32.76	37.74	42.52	45.84	35.34	30.06	22.24	37.99	47.00	53.38	62.32	66.00
Buffalo	29.86	34.53	41.01	38.75	33.76	27.29	19.47	33.61	40.10	47.82	55.33	62.14
Chicago	28.82	34.02	37.41	34.32	25.68	23.38	17.46	32.68	36.51	41.03	46.46	52.27
Cincinnati	27.68	33.79	36.41	30.60	24.04	23.97	17.90	32.47	36.40	40.83	46.27	51.76
Cleveland	28.28	34.38	37.18	35.69	27.26	26.83	18.19	34.50	36.46	41.15	45.24	52.67
Denver	33.68	38.11	40.59	36.10	34.69	28.21	21.10	44.31	50.89	59.53	67.39	75.21
Detroit	28.28	34.80	37.86	31.69	26.63	27.74	15.96	32.63	36.47	40.91	46.42	54.09
Houston	33.36	34.55	38.93	44.02	32.64	27.96	23.54	42.81	47.06	54.33	59.94	67.04
Kansas City	30.56	35.85	39.74	39.49	28.35	29.79	19.72	34.68	41.69	46.71	53.11	61.14
Los Angeles	28.16	34.70	38.37	42.32	35.80	36.02	29.36	42.05	53.29	60.79	66.55	72.70
Memphis	25.34	33.05	34.52	33.57	27.06	28.48	22.33	34.94	36.78	49.96	59.80	69.44
Milwaukee	28.79	34.48	37.09	30.93	24.26	23.51	17.13	32.11	36.70	41.42	45.91	53.21
New York	30.89	37.51	42.55	40.22	34.62	27.21	21.06	41.14	46.00	51.91	61.12	68.72
Philadelphia	29.76	34.88	40.92	44.86	33.39	28.75	20.85	39.37	46.26	55.41	65.77	72.08
Pittsburgh	33.67	39.53	43.78	34.29	37.60	29.92	21.29	30.60	43.01	49.15	55.93	63.28
Portland	28.96	32.08	38.73	36.93	32.88	34.78	27.87	44.85	49.78	57.74	70.44	....
San Francisco	28.84	33.36	38.86	40.88	36.05	34.13	26.13	42.99	54.58	62.64	68.90	76.72
Seattle	23.94	33.41	35.11	34.23	25.49	27.32	26.14	40.05	52.66	66.22	74.14	77.49
Spokane	21.21	30.42	35.65	38.02	35.00	33.77	21.97	43.01	43.20	47.52	....	58.32
St. Louis	29.11	34.60	37.31	34.14	26.19	23.48	18.40	33.76	37.79	42.74	49.38	53.69
St. Paul	28.18	32.65	35.91	37.69	26.91	24.27	17.70	33.96	36.81	41.49	46.69	52.95

Base Quantities. All HR products may be combined for quantity. Hot-rolled sheet, 10 ga x 36 x 96—120; Cold-rolled sheet, 20 ga x 36 x 120; Galv. sheet—16 ga x 36—120; Hot-rolled strip—⅛" x 1"; Plate ¼" x 84/; Shapes—I-Beams 6 x 12.5; Hot-rolled bar—Rounds ¾-2^{15}/$_{16}$; Cold finished bar—C 1018—1" rounds; Alloy bar—Hot-rolled 8620—1⅝" round; Cold drawn—1" round; Hot-rolled 4140—1⅝" round; Cold drawn—1" round. Check local supplier for additions or deductions from base.

*Prices at all points include metropolitan delivery charges.

Codes identify Producers listed in the Key on page 80. (Prices quoted are mill base prices in cents per pound unless otherwise noted and do not reflect extras or surcharges.) N.A. = Not available.

Billets, Blooms, Slabs

(Dollars per net ton)

Carbon Rerolling, Midwest	
W5	$355.00
N4	$366.00
West	
C6	$346.00
Carbon Forging, East	
B3(3), C10, U1	$453.00
R3	$453.00
Midwest	
R3, U1, W5	$453.00
S1	$420.00
C10	$453.00
K2	$453.00
W5	$453.00
West	
B3(2)	$463.00
C6	$453.00
South	
A7	$453.00
Alloy, East	
R3, C10	$492.00
B3	$492.00
Midwest	
W8, W5, C10	$492.00
U1	$492.00
R3	$492.00
S1	$459.00
West	
B3	$502.00
C6	$469.00
South	
A7	$492.00

Piling Sheet Steel

(cents per lb)

Midwest	
U1	26.45

Structurals

Carbon, East	
B3(2)	23.90
U1, J3	23.90
Midwest	
A7	24.15
C20	22.90
W8	22.90
I3, T10, U1, N4	23.90
West	
C6	25.10
U1	24.40
B3(2)	21.65
South	
C16, U1	23.90
T10	22.90
A8	Cmp*
High-Strength, Low Alloy, East	
B3(2)	23.90
U1, J3	23.90
Midwest	
N4	23.90
W8	24.15
U1	23.90
I3	23.90
West	
U1, A7	24.40
B3(2)	21.65
South	
U1, C16	23.90
Wide Flange, Carbon, East	
B3	23.90
U1, A7, J3	23.90
Midwest	
U1	23.90
N4	23.90
I3	23.90
West	
U1	24.40
C6	24.15
South	
A7	24.15

Strip

Hot-Rolled, Carbon, Cut II Edge—all widths, East	
U1, B3	23.75
J3	22.05
Midwest	
A7, D1	22.05
I4	22.85
J3, D1	22.05
W3	22.05
N4	22.55
W5, S1	23.75
U1, B3	23.75
G2, I3, M2, R3, G3	22.05
West	
B3	26.55
South	
R3	22.05
Cold-Rolled, Carbon Max. 25%, East	
E4	29.75
S10	29.60
P15	24.80
U1	38.30
B4	36.60
G6	36.175
Midwest	
I4	38.30
W14	32.80
S1, J4	34.05
S1	37.05
High-Strength, Hot-Rolled, Low Alloy, Cut Edge & Mill Edge—all widths, (plus extras)*	
Midwest	
M2, G3, R3, W3, J3, G2, I3	22.05
A7	22.05
S1	23.75
South	
R3	22.05
High-Strength, Cold-Rolled, Low Alloy, Mill Edge	
Midwest	
S1	37.05
Alloy, Hot-Rolled, Midwest (plus extras)*	
S1	24.60
I4	25.20
Alloy, Cold-Rolled, East	
C11, E4, M8	43.35
B4	47.25
P15	32.10
Midwest	
I4	44.30
S1	42.30

Sheets

Hot-Rolled, Carbon (18 Ga & Hvyr), East	
B3	23.75
J3	22.05
U1	23.75
Midwest	
A7, G2, G3, I3, M2, R3, W3	22.05
D1	22.05
J3	22.05
I4	22.45
U1, W5, S1, B3	23.75
West	
U1	24.25
South	
R3	22.05
Cold-Rolled, East, Class I	
B3(2)	28.15
J3	28.15
U1	28.15
Midwest	
I3, G3, R3, M2	26.15
G2, W3, M11	26.15
I4	22.00
J3, A7	26.15
D1	26.15
U1, W5, S1, B3	28.15
West	
U1	28.65
South	
R3	24.65
Galvanized (hot-dipped), East	
B3(2)	30.30
U1	30.30
Midwest	
J3, D1	28.00
I3	28.00
A7, R3, Y1	28.00
G2, W3, M11	28.00
U1, W5, S1	30.30
West	
U1	30.80
South	
R3	28.00
Enameling, Midwest	
U1, S1	29.65
A7, I3, J3	27.65
Long-Terne, Midwest	
W5	31.65
U1	31.65
R3, A7	29.35

†Actual weight basis

Wire Rod

East	
B3(2)	22.35
U1	22.35
Midwest	
N4	22.35
U1, K2	22.35
West	
A7	22.00
C6	21.45
South	
G7	22.35

Tinplate

Electrolytic Tinplate

Single Reduced (70 lb)

East	per base box
J3	$26.29
U1	27.74
B3	26.32
Midwest	
U1	$27.74
J3	26.29
M11	26.29
W3	26.29
W5	26.29
West	
U1	$28.24
South	
U1	$27.74

Double Reduced (55 lb)**

Midwest	
M11	$21.49
J3	21.49
U1	22.37
W3	21.49
W5	21.49
West	
U1	$22.87
South	
U1	$22.37

Black Plate

Single Reduced (75 lb)*

East	
B3	$23.83
Midwest	
J3	$24.01
M11	24.01
I3, W5	24.01
W3	24.01
U1	25.26
West	
U1	$25.26

Double Reduced (55 lb)

East	
B3	$19.70
Midwest	
M11	$18.93
W5	18.93
J3	18.93
W3	18.93
W5	18.93
U1	19.70
West	
U1	$19.70
South	
U1	$19.70

*70 lb—base weight extra 45¢

**50 lb—base weight extra $1.40

Bars

Carbon Steel, Hot-Rolled

(Special quality)

East	
R3, K3	25.80
R5	25.80
B3(3), J3	25.80
U1, C10	25.80
Midwest	
A7, I4	23.95
U1, I3, C20, N4	25.80
R3, T10	25.80
K2	25.80
I3	19.50*
West	
B3	25.80
C6	24.45
South	
A8	20.65
A7	25.80
C16	25.80
Cold-Finished Carbon, East	
A11	22.15
R3	33.75
C21	21.15
J3(4), L2	31.00
C2	23.025
M8, W10, T11, S8	31.00
N1	24.475
R4	33.25
B4	33.25
M1	23.025
B4, C10	31.00
Midwest	
B5, W10, Y1, W8, R3, M9	33.25
J3	31.00
B1	33.45
L2	30.75
N9	31.00
P3	19.85 ÷ CMS
W14	22.20
J3(3)	31.00
J3	31.00
West	
B5	34.90
R3	37.15
South	
B5	32.85
J3	34.00
C16	24.40
J3	31.95
Alloy, Hot-Rolled, East	
B3(2), R5, K3, C10, U1	27.95
R3	27.95
J3	27.95
Midwest	
A7, U1, R3	27.95
I3, C10	27.95
I4	26.10
I3	21.00*
West	
B3	27.95
B5	18.50
C6	26.60
South	
A7	24.85
A8	22.00
Alloy, Cold Drawn, East	
L2	35.20
R3, N1, C2	37.90
M1	28.025
R4	37.10
A11	30.50
3, W10, L2	34.85
T11, S8	34.85
C10	34.85
J3(2)	34.25
Midwest	
R3, C10	37.35
C2	28.275
J3, W10	34.85
P3	22.75
B1	37.30
N9	34.85
L2	34.65
B5	37.10
J3	36.00
J3	34.85
M9	37.10
West	
R3	40.75
South	
J3	35.85
C16	28.00

Plates

Carbon Steel, East	
B3(2), U1	25.75
L4	25.75
P2	25.75
J3	26.75
Midwest	
B3, R3, S1	25.75
I3	24.25
J3, A7	22.80
U1, I4	25.75
R3	26.75
West	
A7, C6	24.25
U1, B3	25.75
O2	23.00
South	
R3	25.75
A7	25.75
U1	25.75
Alloy, East	
B3, J3	33.55
U1, L4	33.55
P2	33.55
J3	34.55
Midwest	
B3	33.55
G2, G3	33.55
I4, U1	33.55
West	
B3	32.05
O2	31.00
South	
A7	27.55
U1	33.55

Wire

Carbon Steel Wire, East	
B3(2)	27.10
U1	27.70
A11	22.15
Midwest	
U1	27.70
A7, R3	24.60
N4, W7	27.40
K2	24.20
South	
A8	22.85
West	
A7	25.95
C6	24.95

PRICES RISE AT MODERATE PACE

Government officials are using the latest producer price data as evidence that the economy is not overheating as some analysts have alleged.

Overall, producer prices were unchanged in April compared with March, according to the Bureau of Labor Statistics. All individual categories shown at right were up, but each was so slight as to be negligible.

The zero rate of change in April followed three months of acceleration which raised fears that inflation was being re-started. Not so now, says the White House. The producer price figures coupled with the 2.9 pct rise in retail sales show "a solid expansion of the economy without inflation and that the recovery is on course," said White House spokesman Larry Speakes.

The index for capital equipment, which makes up about 22.2 pct of the producer price yardstick, moved up 0.3 pct in April, the same as in March. The largest of the increases was registered for heavy motor trucks, 2.5 pct, all others were in tenths of a percentage point.

The annual rate of increase for the government's producer price index for January through April is a moderate 4.4 pct. Although higher than last year's annual increase of 0.6 pct, the pace is a reassuring sign that prices at the wholesale level are not pressuring consumer prices at retail.

Prices in April for metal-cutting machine tools rose 0.4 pct while those for metalforming machine tools rose 0.2 pct, the same as in March.

The index of intermediate products used in various stages of production edged up 0.1 pct, after seasonal adjustment, following a 0.5 pct jump in March.

Meanwhile, U.S. inventories rose for the ninth consecutive month in March, the latest month for which statistics are currently available. The value of inventories in March was pegged at $531.8 billion, 0.9 pct greater than February.

Latest Month Covered: April 1984

Products	Index Reading For Month (1967 = 100)	Pct Change From Previous Month	Pct Change From Year-Ago Month
Metal Cutting Machine Tools	383.6	+ 0.4	+ 2.3
Metal Forming Machine Tools	421.1	+ 0.2	+ 1.6
Agricultural Machinery & Equip.	335.5	+ 0.8	+ 3.6
Construction Machinery & Equip.	357.6	+ 0.5	+ 1.9
Industrial Process Furnace & Ovens	371.7	+ 0.3	+ 2.8
Industrial Material Handling Equip.	287.6	+ 0.1	+ 1.0
Pumps, Compressors & Allied Equip.	349.3	+ 0.5	+ 0.3
Fluid Power Equip. (Dec. 1970 = 100)	257.4	+ 0.2	+ 2.1
Mechanical Power Transmission Equip.	322.9	+ 0.2	+ 2.5
Automobiles	222.0	0.0	+ 2.6
Motor Trucks—Light	282.4	+ 0.4	+ 4.6
Motor Trucks—Heavy	334.4	+ 2.5	+ 5.3
Railroad Equipment	361.2	+ 0.4	+ 3.2
Fabricated Metal Structural Products	309.3	+ 0.3	+ 2.2
Electric Motors	339.3	+ 0.4	+ 4.4
Valves & Fittings (Dec. 1982 = 100)	101.8	+ 0.7	+ 1.4
Ball & Roller Bearings	338.8	+ 0.7	+ 2.3
Cutting Tools & Accessories	278.3	+ 0.2	+ 1.3
Heating Equipment	250.3	+ 0.6	+ 3.3
Plumbing Fixtures & Brass Fittings	301.4	+ 0.5	+ 4.8
Metal Containers	345.5	0.0	+ 4.1
Miscellaneous Metal Products	292.7	+ 0.3	+ 4.3

Data based on U.S. Labor Dept.'s Producer Price Index